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ABSTRACT

The bibliography contains 308 abstracts of unclassified Rand studies dealing with various aspects of computing technology. The studies selected have all been issued during the period January 1963 through August 1971. The intention is to revise the bibliography at periodic intervals to incorporate new publications. Both subject and author indexes are provided. (Author/MM)

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A BIBLIOGRAPHY OF

Selected Rand Publications

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The Rand Corporation
~~1700 Main Street~~
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⑤ September 1971
RN SB-1036

COMPUTING TECHNOLOGY.

This bibliography contains abstracts of unclassified Rand studies dealing with various aspects of computing technology. The studies selected have all been issued during the period January 1963 through August 1971. The intention is to revise the bibliography at periodic intervals to incorporate new publications.

Both subject and author indexes are provided. In the subject index, each publication is indexed under one or more headings by a modifier followed by the publication number. Abstracts are arranged serially by publication number.

Except for the commercially published books, which are available from the publishers, copies of these publications may be obtained through Rand's Reports Department. A separate order form is included with each copy of the bibliography.

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RM-4506-NASA Integration of Man and Computer in Prelaunch Checkout of Advanced Space Vehicles.

ZIEHE, T. W.

RM-4390-PR Natural Language in Computer Form.
RM-4540-PR The Catalog Input/Output System.
RM-4645-PR The Catalog: A Flexible Data Structure for Magnetic Tape.
RM-4920-PR Computer Routines To Read Natural Text in Complex Formats.
P-3476 The Catalog: A Flexible Structure for Data Storage.

ABSTRACTS

BOOKS

Book The First Six Million Prime Numbers. C. L. Baker, F. J. Gruenberger. 1959.
A table of the first six million prime numbers, printed on 62 microcards. The numbers were sifted out on an IBM 704, by means of a modified version of the process devised by C. B. Poland in 1955. An introduction describes the method in detail. 8 pp. plus 62 microcards. (Published by the Microcard Foundation, 1959, $35.00. Available only from booksellers or the publisher.)

Book Introduction to Electronic Computers. F. J. Gruenberger, D. D. McCracken. 1963.
An introductory text to electronic digital computing. It deals with the power--and limitations--of the computing world. Although the subject is explained in terms of a specific computer (the Model I IBM 1620, with paper-tape input/output), the approach is intended to be general. The emphasis is on the basic principles of the art, beginning with elementary examples developed in machine language and progressing to advanced work in compilers and generators. Much of the text is devoted to a general discussion of ideas that apply equally to any computer. 178 pp. (Published by John Wiley and Sons, 1963, $2.95. Available only from booksellers or the publisher.)

Book Problems for Computer Solution. F. J. Gruenberger, G. Jaffray. 1965.
A selection of 92 practice problems from a broad range of disciplines for the student of digital computing. Problems vary from the simple to the difficult enabling an instructor to challenge the superior student and test the average student's competence. Problems in permutations, roulette, random numbers, baseball standings, compound interest, simple distribution, quality control, and making decisions with FORTRAN are included. The IBM 1620 is used as a reference machine when one is necessary. 417 pp. (Published by John Wiley & Sons, Inc., 1965, $4.50. Available only from booksellers or the publisher.)

Book The International Computer Industry: Innovation and Comparative Advantage. A. J. Harman. 1971.
Prior to their recent awareness of the "technology gap," economists usually

treated technology as equally available in all nations. This book defines "new" industries as those in which technology is limited--such as the computer industry--and a comparative advantage is gained by the nation with the most innovative firms. A model is hypothesized embodying the cumulative value of a firm's innovations in the characteristics of its product. Products are marketed internationally, with each firm facing a demand curve with finite price elasticity. Analyses of firms in the computer industry provide insights into returns from R&D activities as well as into the extent of competition. For example, demand analysis shows that U.S. firms face stiffer competition at home than abroad, and technical supremacy may have little to do with commercial success. When an industry is no longer limited technologically, it becomes "standard," and comparative advantage depends on other factors of production. 192 pp. Bibliog. (Published by Harvard University Press, 1971, $10.00. Available only from booksellers or the publisher.) (Also issued by Rand as R-474, April 1971.) (MW)

Book Approximations for Digital Computers. C. Hastings, Jr. 1955.
An investigation concerning best approximation in the sense of Chebyshev as applied to the problem of making univariate functional data available to the high-speed digital computing machine. Part I serves as an introduction to the collection of approximations presented in Part II. 208 pp. (Published by Princeton University Press, 1955, $5.00. Available only from booksellers or the publisher.)

Book A Data Processing System for State and Local Governments. E. F. R. Hearle, R. J. Mason. 1963.
A study of the nature of data used by state and local governments and the design of comprehensive systems to serve their long-range needs. Research for this book focused on the total complex of functions performed by such governments rather than on the operations of any one agency, so that the analysis is conceptual rather than procedural. Concerned primarily with data processing, not document or record handling, the study describes the characteristics and capabilities of data processing equipment; discusses the functions, structures, relationships, and prospects of state and local governments; analyzes the data these governments handle; proposes the Unified Information System as a long-range goal; and discusses steps that agencies can take both to improve present data systems and to provide logical transition to the Unified Information System envisioned for the 1970's. Appendixes provide further detail about data, present several major principles of data system design, comment on equipment evaluation and selection, and furnish references for additional guidance. 158 pp. Bibliog. (Published by Prentice-Hall, Inc., 1963, $4.95. Available only from booksellers or the publisher.)

Book The SIMSCRIPT II Programming Language. P. J. Kiviat, R. Villanueva, H. M. Markowitz. 1969.
A user's and programmer's manual for SIMSCRIPT II that requires only a basic knowledge of computers and programming language compiler. The manual is divided into five chapters, corresponding to five language "levels." Level 1 is a teaching language designed to introduce programming concepts to nonprogrammers. Level 2 is a language roughly comparable in power to FORTRAN, but departs from it in specific features. Level 3 is comparable in power to ALGOL or PL/I, but with specific differences, and contains information on the new ALPHA mode for alphanumeric manipulations, on writing formatted reports, and on internal editing. Level 4 contains the entity-attribute-set features of SIMSCRIPT, which have been updated and augmented to provide a more powerful list-processing capability. Level 5, the simulation-oriented part of SIMSCRIPT II, contains statements for time advance, event and activity processing, generation of statistical variates, and accumulation and analysis of simulation-generated data. Two new debugging routines, BEFORE and AFTER, enable the monitoring of six complex processes. 399 pp. (MW) (Published by Prentice-Hall, Inc., 1969, $10.95; paperback edition $6.95. Available only from booksellers or the publisher.) (Also published by Rand as R-460-PR, October 1968.)

Book The SIMSCRIPT II Programming Language: Reference Manual. P. J. Kiviat, R. Villanueva. 1969.
A compact reference listing of the syntax and semantics of SIMSCRIPT II, designed for professional programmers already familiar with the language. (SIMSCRIPT II is fully described in *The SIMSCRIPT II Programming Language*, Prentice-Hall, Inc., 1969, $10.95.) The notation employed was chosen for convenience and descriptive power from conventions previously used in computer programming language descriptions. The study describes notation; basic constructs (symbols, primitives, metavariables); statements (nonexecutable, stor-

age allocation, computation, control, input-output, simulation); system-defined values (constants, variables); a system-defined routine (the ORIGIN routine for simulation time); generated attributes, variables, and routines; and library functions. 30 pp. (MW) (Published by Prentice-Hall, Inc., 1969, $2.50. Available only from booksellers or the publisher.) (Also published by Rand as RM-5776-PR, October 1968.)

Book SIMSCRIPT: A Simulation Programming Language. H. M. Markowitz, B. Hausner, H. W. Karr. 1963.
A description of SIMSCRIPT, a general programming system specially adapted to the problems of writing simulation programs. The advantages of SIMSCRIPT are that it reduces the time needed to program simulations of even moderate complexity and provides increased flexibility in modifying such models in accordance with the findings of preliminary analysis and other circumstances. Although SIMSCRIPT may be used as a computer language for nonsimulation problems, the authors emphasize its application to simulation. Detailed instructions and forms for applying SIMSCRIPT are included. 134 pp. (Published by Prentice-Hall, Inc., 1963, $5.00. Available from booksellers or the publisher.)

Book Information Processing Language-V Manual. Edited by A. Newell. 1961.
A manual for Information Processing Language-V (IPL-V), a computer language designed, like some earlier list languages, for work mainly on heuristic programs. Following an introduction to the history and basic ideas of such programming, Section I of this manual gives a simplified and informal account of the elements of IPL-V. Section II presents the complete rules for coding in IPL-V, rules for programs which will be accepted on any of a number of computers. 244 pp. (Published by Prentice-Hall, Inc., 1961, $6.00 (trade edition) and $4.50 (text). Available only from booksellers or the publisher.)

Book The Economics of Computers. W. F. Sharpe. 1969.
A full-scale text intended as a practical guide to administrative and research planners on all aspects of selecting, comparing, and evaluating the cost-effectiveness of general-purpose digital computers. Part I presents the microeconomic theory of value, demand, price, profit, time, risk, costs, inputs, and outputs. Part II is concerned with applications and discusses the computer industry, including manufacturers, software houses, service bureaus, time-sharing services; the sale and rental of computers; the cost effectiveness of computer systems and memory systems, and the pricing of services in-house and out. Most of the work is entirely new, but an attempt is made to draw together such relevant material as is available in widely scattered sources. Conflicting or competing analyses are compared and evaluated. Specific organizations and machines are named throughout. An appendix explains the principles of regression analysis, curve fitting and selection, and sensitivity testing. 581 pp. (Published by Columbia University Press, 1969, $10.00. Available only from booksellers or the publisher.) (MW)

REPORTS

R-495-PR Rand's Chemical Composition Program: A Manual. M. Shapley, L. Cutler. June 1970.
A user's manual for Rand's digital computer program for solving complex chemical composition problems by determining the distribution of chemical species in multicompartmented systems that minimizes the free energy of the system while conserving the mass of each chemical component. The total program, containing more than 35 subprograms, is flexible. During a run, the user may alter the data--e.g., add extra amounts of some chemicals (stresses), thus changing the model's composition and creating a new problem. He may also control some constants, cause computation and printing of certain measures of amount of error, and request various special computations and messages. Finally, the program may be used by either experienced computer programmers or those unfamiliar with programming methods because, first, the user refers to the data element by easily remembered alphanumeric names and, second, he gives operation instructions by control cards containing one alphanumeric word. 228 pp. Ref. Bibliog. (LC)

R-513-NASA A Study of User Behavior in Problemsolving with an Interactive Computer. M. J. Seven, B. W. Boehm, R. A. Watson. April 1971.
A controlled experiment on the effects of forced delay between computer interactions. Twenty subjects of varying experience used JOSS in solving a planning problem. Twelve were locked out between trials

--i.e., after receiving a current set of results. The experimental findings call into question some common beliefs about man-computer interaction. Subjects with a 5-min lockout did better work in less time and used less computer time than those with free access. An 8-min lockout proved disruptive, especially to experienced users. Other findings suggest that self-imposed restraint can also improve problemsolving efficiency, that users' acceptance of the system is not necessarily a valid predictor of system effectiveness, and that users were inaccurate in recalling their problemsolving behavior. There was also evidence that some on-line users felt pressured by the system to interact prematurely. These findings should aid in evaluating interactive systems. 54 pp. Ref. (See also R-520, R-573, R-584, RM-6132.) (Author)

R-514-PR A Markovian Flow Model: The Analysis of Movement in Large-Scale (Military) Personnel Systems. J. W. Merck, K. J. Hall. February 1971.
First of a series of reports describing a model of social mobility to provide information concerning patterns of movement, projections of the existing population into the future, and the impact produced by changes in the rate of movement. The model and computing procedures permit personnel managers to create an information system that describes the social and geographic mobility that military personnel continually undergo. Derived from mathematical concepts of Markovian processes, the model is presented as a series of FORTRAN subroutines capable of being used on a variety of contemporary computers. The model's principal attribute is its capacity to create future expected values given the starting distributions and a matrix of transition probabilities. Other options, ranging from the computation of the transition matrix to the comparison of projections under different conditions, are peripheral subroutines of the model, but give it the flexibility required for complete analysis of the movement of members of a population. (See also R-534, R-535.) 131 pp. Ref. (KB)

R-519-PR Modeling the Video Graphics System: Procedure and Model Description. T. E. Bell. December 1970.
This report presents both the process and results of generating a computer system description for simulation purposes while both hardware and software are under development. The interactive multiterminal Video Graphics System achieves low cost by using as terminals modified television sets whose pictures are continuously refreshed from a video disk by three scan converters driven by a single digital-to-analog converter. An IBM 1800 process controller receives graphic orders from user programs in the connected service machines (IBM 360s) and sends them to the converter; it also handles input from terminals. The documentation history details the activities and elapsed time of each phase of the 57-week effort; it can serve as an aid in estimating the investment required for such an undertaking, and the conclusions can help simulators to document and model more effectively. 92 pp. Ref. (MW)

R-520-NASA Computer Systems Analysis Methodology: Studies in Measuring, Evaluating, and Simulating Computer Systems. B. W. Boehm. September 1970.
A briefing reporting on tools and techniques developed in 4 research efforts in the analysis of complex computer systems (R-513, R-573, R-584, RM-6132). (1) Computer system characteristics and activity can be conveniently modeled in the prototype ECSS (Extendable Computer Systems Simulator) language while maintaining the flexibility and power of SIMSCRIPT II. Standard aspects are handled by service routines, and the user can insert his own ECSS or SIMSCRIPT routines at will. (2) CPU utilization and throughput can be improved 30 to 300 percent by "tuning" multiprogrammed systems. Small changes in workload characteristics can produce large changes in performance. (3) Choosing computers by their performance on benchmark jobs can be disastrous unless the benchmarks are representative of the workload. (4) The complexity of multiprogrammed systems requires techniques for isolation of key factors in any effect. (5) In controlled experiments in interactive man-computer problemsolving, time constraints on console use produced dissatisfaction --but also produced better results and more efficient work. 53 pp. Ref. (MW)

R-525-NASA Mapping by Computer Graphics: Satellite Antenna Coverage. N. C. Ostrander. October 1970.
Description of computer preparation of maps and overlays, especially for satellite antenna coverage. The examples were produced with an IBM 360/65 and S-C 4060 graphical plotter, using a data tape of 10,500 geographic points stored as 374 strings of alternate latitude and longitude values. This is adequate for maps of scale 1:40,000,000 (at which a world map is 40 in. wide). Rectilinear maps, azimuthal maps, and polar perspective

maps (which show the earth as seen from a particular satellite position) are explained, with coordinate transformation equations for each. The most efficient coordinates for rectilinear maps are latitude and longitude; for azimuthal maps, direction cosines. With satellite rays nearly tangent to the earth, using geocentric coordinates and a spherical earth model, coordinates can cause errors of hundreds of miles. Latitude and longitude corrections for the geosynchronous distance of 6.166 earth radii are provided. The methods given were used to illustrate a worldwide television system in R-524. 53 pp. (MW)

R-534-PR A Markovian Flow Model: The Analysis of Movement in Large-Scale (Military) Personnel Systems--Program Reference Manual. K. J. Hall. March 1971.

The second in a series of reports describing a model of social mobility that provides researchers with information on patterns of movement, projections of an existing population, and the impact produced by changes in rates of movement. Intended for the programmer/analyst, this report documents the specifications for generating the state numbers defined for the model and for using the set of FORTRAN subroutines that make up the flow model program package. The report provides summary information on the format of core arrays and tape records and the identification of data sets. The subroutine specifications cover these items: subroutine name, operation, argument list, calling-program dimension requirements, input/output files, control cards, and definitions and programming considerations. 155 pp. Ref. (See also R-514, R-535.) (SM)

R-535-PR A Markovian Flow Model: The Analysis of Movement in Large-Scale (Military) Personnel Systems--Program Listings. K. J. Hall. March 1971.

The third in a series of reports describing a model of social mobility, the study of which will provide researchers with information concerning patterns of movement, projections of existing population trends, and the impact produced by changes in rates of movement. Intended to be used by the programmer/analyst in creating a program library, this report lists the 29 FORTRAN subroutines that perform the operations described in the program package. The storage required on an IBM 360/65 is given for each subroutine. Comment cards contain a step-by-step, natural-language description of source-language statements. These listings will be useful when the programs are to be executed on another computer system, or when a subroutine implementing a new operation is to be written. A sample program is included. 170 pp. Ref. (See also R-514, R-534.) (SM)

R-560-NASA/PR Experience with the Extendable Computer System Simulator. D. W. Kosy. November 1970.

A review of the capabilities of the prototype Extendable Computer System Simulator conceptually described in RM-6132, pointing out strengths and weaknesses of this approach to computer system simulation, and indicating general design principles for computer system simulation language. ECSS complies with these principles in being powerful, flexible, readily extended, easily used, and in producing models that are economical to rerun. However, the user should be given more leeway for unusual cases, including greater freedom to skip undesired operations via a more extensive set of procedural statements. A computer system simulation language should also include automatic collection of statistics, with output summaries or trace output available on demand. A representative ECSS program is appended. 36 pp. Ref. (MW)

R-573-NASA/PR Computer Performance Analysis: Applications of Accounting Data. R. A. Watson. May 1971.

Virtually all third-generation computer systems collect and record computer accounting data. However, these data are seldom used except at those installations that use accounting data to charge for computer services. This report describes the types of accounting data generally available at most computer installations. It then discusses techniques for conditioning and reducing the data, along with various reports on system performance and workload characteristics that can be generated from the data. The report mainly concerns specific applications of accounting-data analysis in computer performance analysis. The most heavily stressed application employs the statistical analysis tools of regression analysis and cluster analysis to measure the effects on performance of a major system modification. Other applications of accounting-data analysis include validating and supplementing the data collected by hardware or software measuring devices, and use in developing effective computing charging schemes. 74 pp. Ref. (Author)

R-584-NASA/PR Computer Performance Analysis: Measurement Objectives and

Tools. T. E. Bell. February 1971.
One of a series of studies on computer performance analysis, this report is concerned with the recognition of objectives and the choice of measurement tools for computer performance analysis. In addition to the conventional tuning objectives, model building, simulation validation, and operational control are important. Data collection tools for measurement and analysis range from simple, inexpensive ones --audio and visual indicators, operator opinions, and logs--to the most sophisticated hardware and software monitors. Each of the simple tools can provide initial indications of performance, but hardware and software monitors are usually necessary for a thorough analysis. Five binary characteristics can describe a monitor: (1) implementation medium, (2) separability, (3) sample portion, (4) analysis concurrency, and (5) data presentation. An analyst should determine the characteristics his analysis requires before choosing the measurement tools. 39 pp. Ref. (DGS)

R-641-PR Generating Gamma Distributed Variates for Computer Simulation Models. M. B. Berman. February 1971.
Compares two methods of generating random variates for simulation studies from gamma distributions with non-integral shape parameters. The commonly used probability switch approximation method is examined for accuracy and computation costs, while Johnk's exact method is investigated for computation costs. The probability switch method approximates the gamma distribution very closely for shape parameters above 5.0, poorly between 1.0 and 5.0, and not at all below 1.0. Johnk's method, while exact, is 2.5 to 3 times slower in the shape parameter range of 1.0 to 5.0. Johnk's method is recommended for shape parameters below 5.0, and the probability switch method is recommended above 5.0. FORTRAN routines for the two methods are provided. The data used to investigate the accuracy of the probability switch method is appended, as are selected plots of the distributions and a discussion of methods to generate beta variates. 52 pp. Ref. (Author)

R-670-PR BOOST: On-Line Computer Program for Estimating Powered-Rocket Performance. D. C. Kephart. February 1971.
User's manual and program listing for BOOST, a quick-response, interactive JOSS program that simulates the powered flight performance of multistage booster rockets. BOOST is tailored for minimum make-ready and fast turnaround to aid planners and analysts in synthesizing new rocket configurations and in exploring variants on existing designs. BOOST "flies" a zero-lift two-dimensional powered trajectory over a spherical nonrotating earth. Coasting stages, earth rotation effects, and the postboost vacuum ballistic trajectory associated with any set of rocket burnout conditions are available as options. Velocity losses due to gravity, aerodynamic drag, and atmosphere/nozzle interaction are considered. The rocket may be earth- or platform-launched into space, the atmosphere, or to the surface. BOOST complements rather than supplants the more detailed Fortran ROCKET program (RM-3534). Appendixes include a summary chart of the JOSS language. 60 pp. Ref. (MW)

R-687-ARPA On-Line Computer Programs for the Analysis of Border-Control Problems. G. F. Schilling, M. Turner. February 1971.
Complex interactions among military, technical, geopolitical, and socioeconomic factors constitute major problems for counterinfiltration programs intended to inhibit the movement of hostile forces across defined boundaries. This report describes two versions of an on-line computer program that incorporates the methodology of a model of border control developed in RM-6250; it enables the user to analyze insurgency situations without mathematical manipulations. The computerized versions of the model permit the ready investigation of specific situations and the rapid testing of new concepts with regard to their probable utility under different contingencies. It also permits testing of quantitative sensitivity analyses of candidate border security systems and programs. Outputs include a detailed account and projected time sequence of the number of guerrillas in the area of interest as a result of infiltration, interdiction, recruitment, and attrition. For any future date, these numerical data are given in terms of actual numbers, area densities, and rates of change. 63 pp. (KB)

R-700/1-PR Soviet Cybernetics Review, Vol. 1, No. 1. Edited by W. B. Holland. February 1971.
Featured in this issue is a report by Barry Boehm of Rand, who was invited by the USSR Academy of Sciences in October to tour prominent Soviet computing centers. His detailed account provides an overview of computing problems and successes in the Soviet Union. Also of special interest is an organizational chart of the Soviet government that identifies all-union minis-

tries and ministries of the union republics, plus important agencies. A survey article on the automation of Soviet railways reveals a number of different areas of railroad operation. In an article discussing automation implementation on a broad scale, an eminent Ukrainian economist identifies specific ways of closing the Soviet R&D gap. A recent International Symposium on Computer-Based Automation of Scientific Research is the basis for an article listing several projects in Novosibirsk intended to facilitate Soviet research--in particular, a light-pen graphics system and the AIST multiple-user time-sharing system. 81 pp. (SCR is available to nongovernment organizations by yearly subscriptions at $48. Single issues: $10.) (KB)

R-700/2-PR Soviet Cybernetics Review, Vol. 1, No. 2. Edited by W. B. Holland. March 1971.
The 1971 State Plan includes a 20% increase in computer production. Cyberneticists Glushkov and Amosov are on the Supreme Soviet. A. P. Ershov is the first computer scientist elected to the USSR Academy of Sciences. The M-3000, largest of the IBM/360-like ASVT series, is in use. With 36 million operations per second, the CDC-7600 at the Joint Institute of Nuclear Research is the fastest computer in the communist world. Some 30 automated management systems for entire industries or economic sectors are being implemented. City management of Leningrad is to be automated. Remote automatic control of automobile traffic in Moscow is now being tested. Czechoslovakia is being pressured to Sovietize her computer industry and restrict it to supplying peripherals and small equipment. Soviet computing still suffers from inadequate planning, personnel, and jobs. The Ministry of the Electrical Engineering Industry has found only 27% of the engineers and 40% of the applied mathematicians it seeks. 58 pp. (SCR is available to nongovernment organizations by yearly subscription at $48. Single issues: $10.) (MW)

R-700/3-PR Soviet Cybernetics Review, Vol. 1, No. 3. Edited by W. B. Holland. May 1971.
The 24th CPSU Congress ordered major national efforts in computing, automation, and systems analysis. High Soviet officials and executives take 3-month courses in the systems approach and econometric methods at the new Institute for Management of the National Economy. The Agriculture Ministry established a cybernetics research institute--the first step toward computational support for farming. Denying a Russian report, CDC states there are no CDC-7600s outside the U.S. Feature articles describe problems with youth; lack of progress on medical electronics and on the State Network of Computer Centers; the Donetsk, AKKORD, and other control systems; the first Soviet work on long-range forecasting; new applied mathematics faculties at 4 universities; a light-pen device that can photograph its alphanumeric and graphic displays. Binary-coded microfilm replaces punchcards and tape in the large computer system being developed by the Weather Service. Extensive feasibility studies for a Belorussian medical reporting system are the first SCR has seen. 67 pp. (SCR is available to nongovernment organizations by yearly subscription at $48. Single issues: $10.) (MW)

R-753-ARPA The Rand Video Graphic System--An Approach to a General User-Computer Graphic Communication System. K. Uncapher. April 1971.
A report prepared for the AGARD Avionics Panel Technical Symposium on Data Handling Devices, Istanbul, Turkey, 1-4 June 1970. Cathode-ray-tube graphic displays offer one of the most powerful and useful man-machine communication paths. The Rand Video Graphic System offers one implementation. It serves 32 consoles; each has a full range of interaction and full graphics, and accommodates up to 8 different input devices. Each console serves as the general graphic terminal for all the user's computer-based needs. The user can access several computers from any terminal. The system is based on the use of an 873-line TV monitor in each terminal. Scan conversion and buffered storage are centralized to improve performance and reduce cost. The report describes system components, operating environment, hardware and software, consoles, and reliability and performance. An all-digital approach to the video system is now being designed at Rand. 20 pp. Ref. (Author)

R-787-NIH Computer Techniques for Pseudocolor Image Enhancement. J. C. Lamar. June 1971.
Description of computer methods of creating color separations for pseudocolor transformations, made possible by improvements in microfilm-generating equipment. A halftone process is chosen in which a picture is divided into many small areas and pseudo-random patterns are plotted in each. Twenty-one patterns are designed. The Datagraphix 4060 is programmed to produce 35mm microfilm frames containing plots of the patterns; their densities are established by densitometer reading. The ex-

amples described are for creating pseudocolor transformations based on the two-separation process, but the techniques are applicable for processes requiring any number of separations. A FORTRAN program has been written to create a 21-step gray scale, with each step a rectangle constructed from the patterns. Two separations of the gray scale are generated by the 4060, and a color scale is produced using the separations as the red and blue records in the two-separation process. A pseudocolor transformation of an image is created also from digital data. 44 pp. Ref. (See also R-596, R-597, RM-5297.) (KB)

RAND MEMORANDA

RM-3173-PR Dynamic Programming, Intelligent Machines, and Self-Organizing Systems. R. E. Bellman. June 1962.

A discussion of some aspects of problem formulation and problem solution. The relevance of these matters to the field of intelligent machines is emphasized, some connections with the theory and application of dynamic programming are indicated, and the practical application of scientific philosophy as a technique to guide research is considered. 22 pp.

RM-3245-PR Factors in Selecting and Training Programmers. A. Sweetland. August 1962.

An attempt to develop criteria for the selection and training of computer programmers. Section I evaluates nine classes of programmer trainees according to their intelligence, motivation, and classroom performance. Section II discusses vocational interest inventory. Section III suggests areas in which further research might be fruitful (e.g., programmer characteristics, interests, and aptitudes). 25 pp.

RM-3273-PR DETAB-X: An Improved Business-Oriented Computer Language. S. L. Pollack. August 1962.

A description of a computer language based on the use of decision tables, DETAB-X (Decision Tables, Experimental). The memorandum traces the evolution of computer programming and the steps in its development. The desirable features for a problem-analysis technique are discussed, together with a comparison of DETAB-X and COBOL-61. DETAB-X was developed at Rand as part of a continuing effort to devise methods that will permit the Air Force and other large users of computers to reduce costs and time-lags involved in designing and implementing data systems. 25 pp.

RM-3283-PR Some Problems of Basic Organization in Problem-Solving Programs. A. Newell. December 1962.

Part of a continuing study dealing with artificial intelligence and with how humans process information. The study will eventually lead to computer programming techniques that will permit the construction of more sophisticated problem-solving programs than the game-playing and theorem-solving type of program common today. This Memorandum discusses several of the organizational issues involved in constructing a problem-solving program and in applying it to actual problems in an effort to detect the sources of information contained in the program. 68 pp.

RM-3285-1-PR Learning, Generality and Problem-Solving. A. Newell. February 1963.

A revision of RM-3285. This memorandum discusses the role of learning in relationship to other concepts in the field of artificial intelligence, such as generality and problem solving. A Rand computer program for learning, known as the General Problem Solver, is described and its operation is discussed. 41 pp.

RM-3306-PR FORTAB: A Decision Table Language for Scientific Computing Applications. G. W. Armerding. September 1962.

A description of a computer language, FORTAB, developed at Rand as an aid to computer programming. FORTAB is a decision table language designed to be imbedded in the well-established FORTRAN scientific computing language. Together they provide a strong combination of computational depth and program logic. 46 pp.

RM-3320-PR AUTOSATE--Part II: Event-Chain Flow Charting. O. T. Gatto, E. M. Fairbrother. December 1962.

A description of event-chain flow charting, a computer process that produces one of a series of analysis reports for AUTOSATE (an Automated Data Systems Analysis Technique). The concept of event chains departs from the usual practice of flow charting by "application" in that emphasis in the chaining process is on the event creating the document rather than on the application to which it belongs. Event chains as control devices are also examined as they were used to test the consistency, compatibility, and completeness of a proposed Depot Maintenance Industrial Management System at Headquarters, AFLC. The computer program flow charts and instructions are provided for those interested in making surveys of both proposed and operational data systems using the event-chain process of AUTOSATE. 103 pp.

RM-3324-PR The Fifth Rand Computer Symposium. Edited by F. J. Gruenberger. November 1962.
An abridged transcript of the Fifth Annual Rand Computer Symposium, held at The Rand Corporation, April 1962. The meeting centered around the use of common computer languages in command and control. The Pentagon's announced disposition toward one such language, COBOL, received considerable comment, and a definite question was raised concerning the advisability of adopting a common language for command and control at this time. The implications, both in dollars-and-cents terms and in the possible effect on the development of the state of the art, could have a bearing on future Air Force programs. 197 pp.

RM-3327-PR The Rand-SHARE Operating System Manual for the IBM 7090 Computer. Edited by G. E. Bryan. September 1962.
A manual of programmers' aids developed at Rand in cooperation with SHARE, an organization of computer users formed to facilitate the exchange of computer programs, for use on the IBM 7090. The manual assumes that the reader is familiar with the SHARE SOS Manual, and with the published descriptions of the other processors, and is concerned with the changes and additions that have been made in the various components of the operating system. The study has application in military and civilian establishments where data processing machinery is used. 117 pp.

RM-3337-PR A Guide to the General Problem-Solver Program GPS-2-2. A. Newell. February 1963.
A detailed account of the internal structure of GPS-2-2, one of the versions of the General Problem Solver (GPS), a computer program for explorations into both the general mechanisms involved in problem solving and the way humans solve problems. The gross topography of the program and a run-through of a simple problem to put the parts in context are given. The rest of the memorandum is taken up with the various data structures used in GPS, the subroutine hierarchy, the embedding program used to put GPS into operation and receive outputs on selected aspects of its performance, and the information provided for each task environment. 158 pp.

RM-3447-PR Programming Languages and Standardization in Command and Control. J. P. Haverty, R. L. Patrick. January 1963.
A study of computer programming languages in the field of command and control. An evaluation of current programming languages indicates that it is not now appropriate to establish a standard programming language, but that planning for standardization should begin immediately. Particularly needed are a data-processing glossary, magnetic tape recording formats, and character sets. Also needed is a central Air Force agency to establish measures of performance, plan for standardization, and coordinate computer selection. The study suggests that the Air Force take the lead in directing and supporting research efforts to improve the state-of-the-art, and that the present indoctrination program in computers and computer programming for Air Force officers be supplemented by courses in the established USAF schools. In addition, a training program is urgently needed to develop a cadre of skilled programmers in the Air Force. 75 pp.

RM-3588-PR The Heuristic Compiler. H. A. Simon. May 1963.
An investigation of the kinds of problem-solving activity that are involved in computer programming and the kinds of language and representational means that are needed to produce more sophisticated compilers. Two major themes are presented: (1) More of the programming burden can be shifted from programmer to computer if the computer is given some problem-solving powers; and (2) if we are to have flexibility in a compiler language commensurate with the flexibility of natural language, we must first gain an understanding of the ways in which meanings are represented in natural language, and then devise representations of corresponding power (and ambiguity) for compiling languages. 137 pp.

RM-3609-PR A Computing Program for Determining Certain Statistical Parameters Associated with Position and Velocity Errors for Orbiting and Re-

entering Space Vehicles. R. T. Gabler, S. J. Belcher, G. D. Johnson. April 1963.
A computing program for determining errors in position and velocity on a satellite orbit. Error coefficients are computed from analytic formulas. These may be used in the further computation of systematic and random errors in the prediction of satellite position and velocity. The computing program handles the propagation of variance-covariance and the determination of confidence regions for position and velocity estimates. 61 pp.

RM-3646-PR A Generalized Assembly System. G. H. Mealy. August 1963.
A presentation of the first results of research aiming to consolidate and extend the state of the art of computer assembly system design and implementation. Assembly systems are the real core of modern programming used to prepare problems for calculation of solutions in digital computers. The importance of proper design of these systems is especially apparent in the implementation of such large control programs as SAGE and SACCS. The research vehicle covered here is the Generalized Assembly System (GAS), programmed in an experimental form for the 7090 Data Processing System by the author. 81 pp.

RM-3669-PR Analysis of the Decision Rules in Decision Tables. S. L. Pollack. May 1963.
A discussion of decision tables, a framework for describing a set of related decision rules. The tables can improve the communication and documentation achieved by previous techniques such as flow charts and narrative descriptions of data processing problems, particularly those with complex decision rules. Decision tables also offer system analysts the possibility of eliminating inconsistencies and redundancies in each set of specified decision rules and of producing programs efficient in the use of computer storage and running time. They also enable the system analyst to determine if he has considered all the possible decision rules that can be formed from a particular set of conditions. The author develops for decision tables a theoretical structure that serves as the foundation for achieving these benefits. 77 pp.

RM-3675-PR Soviet Cybernetics Technology: I. Soviet Cybernetics, 1959-1962. Edited by W. H. Ware, W. B. Holland. June 1963.
Seven sets of translations in the area of Soviet cybernetics, together with commentary and analyses on the status of cybernetics in the Soviet Union, and the directions of Soviet cybernetics research. This volume is concerned with general computer technology and cybernetics applications. Two more are anticipated: Volume II will be on programming for specific computers; Volume III, on hardware and specific machines. 104 pp.

RM-3731-CC The Logic Theory Machine: A Model Heuristic Program. E. Stefferud. June 1963.
A highly detailed program listing for the Logic Theory Machine (LT), a computer program written in Information Processing Language-V (IPL-V), and developed especially for use as a pedagogical model. The text portions expand on the documentation in the listing, tracing program flow, analyzing routines used, and providing insight into the structure and development of the program. LT was originally programmed in an early version of IPL to derive proofs of logic expressions in the sentential calculus of Whitehead and Russell. In rewriting it for use as a teaching aid, a new method of replacement on sub-expressions has been included, and many minor changes effecting improvements in clarity have been incorporated. Features of the code that were unjustifiably hard to explain have been simplified. LT can be implemented on any computer for which an IPL-V processor is available. 196 pp.

RM-3753-ARPA Computer Recognition of On-Line, Hand-Written Characters. M. I. Bernstein. October 1964.
Discussion of a method for recognizing single, hand-written characters using an on-line graphical input device such as a digitizing pantograph, light pen, or RAND Graphic Input Tablet, as the primary information source. Basically, the method consists of filtering and smoothing the input stream to eliminate as much redundancy as possible. Direction of the stylus movement is quantized into one of eight directions, allowing each stroke of a character to be described as a series of connected straight-line segments. By eliminating various measures on the stroke, the description is size-, position-, and rotation-independent. To restore some rotational orientation and to discriminate between open, closed, and multi-stroke characters, end-point comparisons are added to the description. 33 pp. (See also RM-4122-ARPA.)

RM-3778-PR A Brief Review of SIMSCRIPT as a Simulating Technique. M. A. Geisler, H. M. Markowitz. July 1963.
A presentation of the underlying concepts and structure of SIMSCRIPT. It is maintained that the key to understanding the language of simulation and to developing a more rigorous approach to simulation is to have a SIMSCRIPT view of the world in terms of events, sets, and entities. A specific example of a simple job shop routine is given to support this view. The memorandum concludes with a review of the 1963 status of SIMSCRIPT. 28 pp.

RM-3797-PR Soviet Cybernetics Technology: II. General Characteristics of Several Soviet Computers. Edited by W. H. Ware, W. B. Holland. August 1963.
A collection of annotated translations concerning eight Soviet and Soviet bloc computers. Noteworthy is the inclusion of information on two little-known machines, the "Luch" (Byelorussian) and the "EPOS" (Czechoslovakian), and some commentary on the "Ural-4." An article on the "BESM-II" contradicts information from other sources. 78 pp. (See also RM-2541, RM-3675.)

RM-3804-PR Soviet Cybernetics Technology: III, Programming Elements of the BESM, STRELA, Ural, M-3, and Kiev Computers. Edited by W. H. Ware, W. B. Holland; translated from the Russian by A. S. Kozak. September 1963.
A translation from the Russian detailing the instruction formats for five of the better known Soviet digital computers. Some notes are included to help place the machines in perspective. Charts give the operation codes for the five machines, along with the original Russian terminology and its English translation. 91 pp. (See also RM-3675, RM-3797.)

RM-3813-PR Technical Appendix on the SIMSCRIPT Simulation Programming Language. B. Hausner, H. M. Markowitz. August 1963.
Five tables presenting miscellaneous information which may be of value to the programmer who wishes to use SIMSCRIPT in some unusual way or to modify the SIMSCRIPT translator: (1) the layout of region IV, above 31,000; (2) a short description of each routine in the "System Package"; (3) a short description of each routine in the Translator; (4) a listing of FAP routine, KLRXX, which removes the first event of a specified type from the calendar; (5) an alphabetic listing of the table of contents of the SIMSCRIPT manual. 18 pp.

RM-3842-PR A Comparison of List-Processing Computer Languages. D. G. Bobrow, B. Raphael. October 1963.
A detailed comparison of COMIT, IPL-V, LISP 1.5, and SLIP--four well-known list-processing computer languages which, among them, exhibit all the principal characteristics of existing list-processing languages. Important common features of list-processing languages are reviewed, and principal differences between the four languages are detailed. A rough comparison shows that the languages discussed are all of approximately the same speed. Some heuristics are given to aid in the selection of one of these languages for use in particular problem applications, concluding that no one of the languages considered is distinctly superior to all possible list-processing applications. 44 pp.

RM-3879-PR TIPL: Teach Information Processing Language. R. Dupchak. October 1963.
A presentation of TIPL (Teach Information Processing Language), a computer program which checks the correctness of solutions to problems written in Information Processing Language-V (IPL-V). It is a teaching aid designed to evaluate automatically both the correctness and the efficiency of a student's program. The first section of the report is intended for the student. It describes how he must prepare his program deck and what conventions he must observe. The second section describes how the system operates and the manner in which the instructor may modify old problems and add new ones. 32 pp.

RM-3976-PR Data System Design and Control Using AUTOSATE--An Automated Data System Analysis Technique. D. D. Butler, E. M. Fairbrother, O. T. Gatto. February 1964.
Data system analysis, design, and control are growing areas of importance as the Air Force increasingly employs electronic data processors. This memorandum describes an automated data system analysis technique (AUTOSATE) that can be used as an aid in these three areas by providing information on data system flows and characteristics for the data system analysis phase and by furnishing a useful tool to guide system design and control. Included are all the operator instructions, program logic flow charts, and FORTRAN instruction listings

for those interested in applying the technique to data system surveys of both proposed and operational systems. 256 pp. (Supersedes RM-3118.)

RM-4033-PR Computer Personnel Research Group Programmer Performance Prediction Study. R. N. Reinstedt, B. C. Hammidi, S. H. Peres, E. L. Ricard. March 1964.
A report of the results of a study undertaken by the Computer Personnel Research Group to gain some insight into the relationship between rated job performance on the one hand, and, on the other, cognitive abilities, vocational interests, and biographical information of computer programmers. A test battery composed of the IBM Programmer Aptitude Test, the Test of Sequential Instructions (a research instrument specially constructed for this study), the Strong Vocational Interest Blank, and a Personal Background Data Form was administered to 534 programmers (301 scientific and 233 business) representing 24 participating companies. 71 pp.

RM-4122-ARPA The RAND Tablet: A Man-Machine Graphical Communication Device. M. Davis, T. O. Ellis. August 1964.
Description of a low-cost, two-dimensional graphic input tablet and stylus developed to conduct research on man-machine graphical communications. The tablet is a printed-circuit screen complete with printed-circuit capacitive-coupled encoders with 40 external connections. The writing surface is a 10" x 10" area with a resolution of 100 lines per inch in both x and y. The system does not require a computer-controlled scanning system to locate and track the stylus. 30 pp. Bibliog.

RM-4133-PR Introduction to COBOL Programming. R. H. Gregory, R. L. Van Horn. April 1965.
An introduction to computer programming with COBOL (Common Business-Oriented Language), using COBOL-1, a simplified and completely compatible subset of COBOL that preserves the essential structure of the language, but minimizes the number of rules and options the student has to learn in the initial stage. The steps involved in using a COBOL program are described and illustrated: (1) program translation into machine language by a data processor; (2) use of the resulting machine language to control the data processing. 140 pp. Bibliog.

RM-4162-PR JOSS: Scenario of a Filmed Report. C. L. Baker. June 1964.
A description of JOSS (Johnniac Open Shop System), an on-line, time-shared use of the Rand Johnniac computer, providing computational service at a number of remote electric typewriter consoles. As many as eight users at once may communicate with JOSS by means of a smooth language, specifically designed for on-line problem solving. JOSS handles many formula evaluation problems, providing the facility of a printing desk calculator as well as the capabilities of a stored-program computer. It also provides various arithmetic and trigonometric functions and allows flexible output in user-specified formats. A console consists of a standard IBM 868 typewriter with a slightly modified character set and a small box with a few indicator lights and activating switches. It uses continuous-feed, sprocket-guide, single-ply paper in 8 1/2 x 11 sheets. The user's input of instructions and data is type in green, and JOSS responses in black. This Memorandum contains the narration accompanying the filmed demonstration, the user's inputs, and the resulting computer outputs; little of the staging and action is described. Appendixes contain statements of the problems solved during the demonstration and the longer, more detailed outputs, and answers to frequently asked questions about the system. 51 pp.

RM-4188-PR Studies in Data System Development: The Air Reserve Records Center. S. L. Pollack. July 1964.
A description of the electronic data processing system of the Air Reserve Records Center (ARRC). During its development and implementation, it encountered many problems that other large-scale systems have faced or will face. This memorandum describes solutions to some of these problems and explains several unique and worthwhile features that were incorporated into the Records Center's system. The study first describes the background for its development, including the major steps leading to the current electronic data processing system. It then discusses its special features, and finally compares early proposals with the current system. 58 pp.

RM-4220-PR Studies in Data System Development: The OCAMA Weapon System Project. E. F. R. Hearle, R. J. Mason. April 1965.
An examination of a pioneering Air Force effort to apply the computer to inventory management--the stock control and distri-

bution system developed and operated by the Oklahoma City Air Materiel Area (OCAMA). The Memorandum discusses changes in system concepts, operations, and data-processing equipment configuration over the past nine years. Conclusions are drawn for guidance in developing other large scale data systems. 55 pp. (See also RM-4188.)

RM-4232-PR A Technique for Improving the Management of a Computer Installation. P. L. Patrick. September 1964.
Describes the benefits of an informal technique for computer installation managers to control the work force and gather data suitable for reports to management. The memorandum includes a statement of the development of the technique, a full description of the computer operations array, the uses of the management tool, and some examples of the system's efficiency in a computer operation handling a stated work load at minimum cost. 62 pp.

RM-4242-PR Modify and Restart Routines for SIMSCRIPT Experiments. H. M. Markowitz, R. C. Steorts. June 1965.
A presentation of routines to be used with any SIMSCRIPT simulation program. They provide snapshot, modify, and restart capabilities for the following game and experiment applications: (1) man/machine games in which the computer simulates a system for a period of time, humans then use the results to decide on changes in policy parameters for the following periods, and the computer resumes simulations where it left off but with policy parameters modified; and (2) simulation experiments in which snapshots of the simulated system are recorded on tape at various points in time. After inspecting the periodic and summary print-outs produced by the simulation, an analyst may specify a return to some snapshot, modify one or more parameters, and resume simulation at that point. While this revised simulation is running, additional snapshots may be taken so that the process can be repeated. 69 pp.

RM-4258 PALL: RAND's Automated Address Book. G. E. Bryan. September 1964.
A description of a computer program designed to improve the accuracy, speed, and convenience of handling the paperwork involved in distributing publications of the RAND Corporation. PALL (Prints Address Lists and Labels) maintains a master file of some 850 organizations approved to receive various categories of RAND reports. In design and operation, the program resembles a two-pass assembler and makes extensive use of modern string-handling, pointer, and dictionary techniques. 91 pp.

RM-4320-PR LIPL: Linear Information Processing Language. R. Dupchak. February 1965.
Presentation of a new alternate format in which IPL routines and data can be represented. LIPL, a horizontal, linear, parenthesis format, is described. The memorandum also presents a new IPL Basic Process, J164, for in-process loading of LIPL routines and data. A description and listing of the J164 routine is included. 67 pp.

RM-4346-PR Factors Affecting Coding Errors. S. Owsowitz, A. Sweetland. April 1965.
A discussion of several studies to determine the major factors contributing to coding errors, the biggest problem in any information system. The studies employ various codes--numeric, alpha, alphanumeric, and mnemonic--and use as subjects Air Force maintenance personnel whose coding routine is similar to the method of recording real-world maintenance data. Their coded information is keypunched and the resulting decks analyzed to determine which factors led to the highest and lowest error rates. The twelve major findings are given in detail, and appear sufficient to serve as testable hypotheses for further experimentation. 38 pp.

RM-4390-PR Natural Language in Computer Form. M. Kay, T. W. Ziehe. February 1965.
Description of a scheme for recording text in computer-useable form so that all meaningful typographical distinctions are represented in a standard format. Provision is made for texts in different languages and different alphabets, and for subsidiary material such as parallel translations and comments of interest to users and librarians. The basic set of encoding conventions is indefinitely extensible to accommodate new kinds of material. In particular, the memorandum: (1) provides special facilities for very large bodies of data (by embedding the text encoding scheme in a general file maintenance system), and a means of correcting and revising filed material; (2) describes computer programs which simplify conversion of text from various sources into the standard format; (3) discusses the problem of and describes a flexible

program for printing text which has been recorded in standard format. 90 pp.

RM-4395-PR Description of the Computer Program for Aggregate Base Stockage Policy of Recoverable Items. J. Y. Lu, G. A. Michels. April 1965.
A description of a computer program to calculate stock levels across a set of recoverable items which are generally characterized by high unit cost and low demand. The inventory policy followed is to reorder a unit whenever one is demanded. The assumed demand distribution is a stuttering Poisson while the distribution of response time is arbitrary, since only the mean response time needs to be known. The technique of Bayesian inference is used for demand prediction. Included with the program (written in FORTRAN IV) is a description of the structuring of the entire program, flow charts, a definition of the variables, and a listing of the source program. 80 pp.

RM-4431-PR Digital Communications and EDP for an Advanced Tactical Air Control System: A Preliminary Study. G. M. Northrop. January 1965.
A brief study offering suggestions for circumventing some of the potential difficulties that may arise with the introduction of digital communications and data processing in an Advanced Tactical Air Control System. A three-phase program of equipment acquisition is outlined, Phase I of which would enhance present capability while acquiring field experience leading in an evolutionary manner to specific operational requirements for more complex system elements. 30 pp.

RM-4460-PR Programming by Questionnaire. A. S. Ginsberg, H. M. Markowitz, P. M. Oldfather. April 1965.
A description of the program generation concept, or programming by questionnaire, a technique for reducing the cost and time required to produce computer programs within specified areas of application. The memorandum describes the technique, compares it to existing techniques, and discusses potential uses. The method is described in terms of the Job Shop Simulation Program Generator (JSSPG), an example developed to test the feasibility and desirability of the concept. 49 pp.

RM-4461-PR Soviet Cybernetics Technology: IV. Descriptions of the MN-11, MN-M, and MN-7 Analog Computers and of Three Miscellaneous Electronic Devices. Translated and edited by W. B. Holland. February 1965.
A collection of translations detailing technical specifications of three Soviet analog computers, and of the BPZ-1 fixed-delay unit, the I-5 CRT indicator, and the VPRR-2 electronic device for controlling tooling modes. The translations have been made from equipment specification brochures prepared for use by the Soviet technical and scientific community and for use at exhibits and trade fairs. Because of this and because authors and origins of the information are not given, there are some questions concerning technical accuracy or intended meaning.
27 pp. Bibliog. (See also RM-3675, RM-3797, RM-3804.)

RM-4467-PR Some Reflections on a Survey of Research Problems in Computer Software. F. M. Tonge. April 1965.
A review of the role of software in computer usage and suggestions concerning appropriate directions and emphases for software research. Primary focus is on the development of computer languages and representations, the efficiency of the programming and translation processes, and the environment in which programmers and programs interact. The key problem of making computers accessible to the nonprofessional user is also discussed.
32 pp.

RM-4506-NASA Integration of Man and Computer in Prelaunch Checkout of Advanced Space Vehicles. R. D. Pepler, J. G. Wohl. April 1965.
An analysis of the roles, information, and interface display and control requirements for different levels of checkout system automation. The levels of automation considered are: (1) manual (the computer is primarily used as a switching matrix); (2) minimal (some of the more routine control and evaluation functions are delegated to the computer); (3) moderate (the test engineer can learn more about his system's performance through feedback and reference information); and (4) advanced (the checkout system can adapt to pretest modifications and can reprogram test operations on line). The study distinguishes between the hardware and software aspects of a man/computer interface and stresses the importance of programming rather than panel and console design. 92 pp.

RM-4511-ARPA The Reliablility of Ground-Based Digital Computers. R. R. Lowe, M. Warshaw. June 1965.
An attempt to estimate the availability of a data processor by starting with the smallest part and investigating its failure behavior, while concurrently constructing a mathematical model of system availability which gives the desired results for a wide variety of systems if the failure behavior of the part, the service features, and the size of the system are know. Estimates of current and predicted systems availability appear as a function of the size of the processor and the type of service provided. Also studied are problems of circuit design, logical design, programming, and maintenance. 292 pp. Bibliog.

RM-4540-PR The Catalog Input/Output System. M. Kay, F. Valadez, T. W. Ziehe. March 1966.
A complete definition of the format used for catalogs on magnetic tape and a description of the routines of the Catalog Input/Output System. Catalog maps, catalog data, and tape labels are written as logical records in a specially designed blocking format. Beginnings and ends of blocks, physical tapes, and catalogs are explicitly marked. The Catalog Input/Output System offers a variety of input/output unit-control operations in addition to the commands for reading and writing data in catalog format. The reading and writing commands are implemented on three levels: Level III handles individual data; Level II reads and writes logical records; and Level I processes blocks of information. 71 pp. (See also RM-4645.)

RM-4563-PR Computer-Assisted Maintenance Planning. P. J. Kiviat. July 1965.
A description of a computer program for planning and scheduling base maintenance, support and training activities. The inputs are descriptions of base flying programs and maintenance, support and training policies; the outputs are displays of base requirements for personnel and equipment, workload control job check lists, and personnel and equipment dispatch orders. These outputs take into consideration the scheduled maintenance support and training tasks, but do not provide estimates of manpower or equipment for unscheduled maintenance. 62 pp.

RM-4573-NASA Separable Redundant Computers. L. D. Amdahl, L. T. Mast. September 1965.
A suggestion for an arrangement of computer triple redundancy to provide three levels of computational capability: (a) a triply redundant computer, (b) a dually redundant computer plus a single computer capable of working independently, and (c) three functionally independent computers. This arrangement allows a failed unit to be switched out and shut down for repair while still providing built-in self-checking of an operating computer system. 40 pp.

RM-4636-PR Tabular Representations of Multivariate Functions--With Applications to Topographic Modeling. B. W. Boehm. February 1967.
An analysis of the computational space-time tradeoff for various tabular representations of multivariate functions, particularly topographic representation techniques. Performance comparisons as related to terrain smoothness, terrain diversification, and accuracy of depiction are made of two contour methods, two uniform grid methods, and the Rand variable grid (microgrid) differential altitude method of tabular representation. The microgrid representation is found to be generally superior, but many problems have special properties which make other methods more efficient. The formulas given are upper bounds of time and cost for each method; they show whether or not it is necessary to analyze a problem for special structure to make it computationally tractable. Polynomial, statistical, and analog methods are discussed briefly. Graphic input devices, such as the RAND Tablet, facilitate preprocessing and reduce costs in elapsed time and dollars. Appendixes give an algorithm and convergence theorem for the contour tree representation, and describe the Rand microgrid. 80 pp. Ref. (See also RM-5081.)

RM-4645-PR The Catalog: A Flexible Data Structure for Magnetic Tape. M. Kay, T. W. Ziehe. October 1965.
An outline of a generalized storage scheme for large files of highly structured data (or catalogs) and a description of their realization on magnetic tape. Each datum, large or small, is assigned to one of a number of data classes of which a user may define any number. The over-all organization of a catalog is given by a map that imposes a tree structure on the set of data classes. Catalogs may participate as individual data in other catalogs so that the structure of a file may be recursive. A flexible addressing scheme not only facilitates the retrieval of data and

sets of data in response to easily formulated requests but also provides a basis for updating catalogs. General procedures called transformations can be used to derive catalogs with new structures from existing catalogs. 32 pp. (See also RM-4390.)

RM-4729-PR Event-Chain Flow Charting in AUTOSATE: A New Version. D. D. Butler, O. T. Gatto. October 1965.
A description of a new and more flexible automatic event-chain flowcharting technique built on the earlier AUTOSATE method. The Memorandum: (1) discusses the system's three phases (documenting system flows, translating inputs into machine-readable form, and producing event-chain flow charts by computer); (2) compares the new system with the old and considers the changes that produced it; (3) analyzes the system's four options for outputs and processing; and (4) offers detailed process charts, programs listings, and operating instructions. 77 pp. (See also RM-3118, RM-3320, RM-3976.)

RM-4782-PR A Computer Simulation of Adaptive Routing Techniques for Distributed Communications Systems. B. W. Boehm, R. Mobley. February 1966.
Description of a computer model of a distributed communications system. It is written in FORTRAN IV and is designed to test various adaptive message routing techniques. The program simulates the progress of messages through the system and measures the effects of the routing techniques' adaptation to specified degrees of destruction of its links and nodes. A listing of the program is given, plus the pitfalls to avoid in developing similar programs. 44 pp.

RM-4793-PR Relational Data File: A tool for Mechanized Inference Execution and Data Retrieval. R. E. Levien, M. E. Maron. December 1965.
A description of the background and status of a current project on automatic data storage and retrieval. The research emphasizes the development and testing of logical techniques for data retrieval and inference-making. The techniques are being implemented in the form of computer routines and tested on a large body of facts concerning the field of cybernetics. Various sections present the theoretical base of the proposed system, a summary of the theory of relations, typical data retrieval requests, the key problems of inference, techniques for practical realization of the data file, output problems, storage and processing problems, the data file as a whole, the question of literature searching, and future steps to be taken to extend the capability of the system. 102 pp.

RM-4810-PR Soviet Cybernetics Technology: V. Soviet Process Control Computers. Translated by W. B. Holland, J. B. Gazley. Edited by W. H. Ware, W. B. Holland. November 1965.
Details of eight recently developed Soviet control computers. The translations from Soviet source material (where information on the machines appeared) are extensively annotated. All pictures and diagrams from the original source items are included, as well as several photographs from other sources. The editors have appended many explanatory notes and comments, and have carefully checked each machine description from a technological standpoint. An appendix contains an alphabetical listing of all abbreviations used in the original Russian texts. 92 pp.

RM-4849-PR Integrating Base Maintenance Management by Unifying Its Information Systems in Manual and Computer-Assisted Environments. I. K. Cohen, E. V. Denardo, P. J. Kiviat. June 1966.
Suggestions for improving maintenance management by unifying the information system and by integrating the many functions of the team. The suggested innovations are: (1) integration of several manual data acquisition systems around the on-going control of flight-line maintenance; (2) extension of this integration to allied maintenance functions; (3) use of a computer to generate documents for the management of preplanned activities; (4) integration of other maintenance functions with No. (3); and (5) full use of an on-line computer for further improvement of the real-time function and coordination of several maintenance management functions. These steps are to be viewed as a general guide rather than as a rigid sequence of implementation. 73 pp.

RM-4920-PR Computer Routines To Read Natural Text in Complex Formats. P. A. Graves, D. G. Hays, M. Kay, T. W. Ziehe. August 1966.
A description of a system of IBM 7040/44 subroutines that will accept natural-language input with complex formats--e.g., from books, journals, questionnaires, clippings, library catalog cards--prepared by any typesetting device or other

machine (typewriter, keypunch, etc.). Inputs are transcribed by the computer into a standard code for machine processing and can be rearranged into any desired format for storage or output. Different kinds of information are recognized by explicit markers, position on the line or page, or syntactic clues given by other items. The subroutines can be used singly or together; they may be called from either FORTRAN or MAP programs. A detailed programmers' guide is included. 143 pp.

RM-5005-NASA Report on a Demonstration Test of Computer-Assisted Countdown. S. M. Drezner, O. T. Gatto, T. D. Wisniewski. March 1966.

An investigation of the interaction between man and computer in a countdown environment. Possible benefits and problems of extending computer control are also explored. The demonstration test examines countdown from the executive-control level, i.e., launch director, test supervisor, or launch-vehicle test conductor. Tests and operations appear as in a normal countdown script. Major hardware test components consist of the computer and the Rand Tablet, a man/machine graphical communication device. Using the Rand graphic system, the executive can experiment, interrogate, predict, issue commands, and receive responses on a cathode ray tube display from the central processing unit. Outputs presented include information dealing with time, script, status, and operational and engineering data. The test introduces an innovation that enables the executive to act on-line with a simulation of the countdown: he can make changes to the script or to the simulation. 38 pp.

RM-5016-ARPA Real-Time Recognition of Handprinted Text. G. F. Groner. October 1966.

Describes a program, written in IBM 360 Assembly Language, that allows the user of an on-line computer to print data and directives on the RAND Tablet with a special pen and have them recognized and displayed immediately. The scheme recognizes 53 letters, numbers, and symbols in a wide variety of printing styles, requiring only the usual conventions followed on coding forms. High-resolution point-by-point pen location data are gathered, displayed on the cathode ray tube screen, and analyzed while the character is being written or drawn. An average 100 data points per stroke (one each 4 msec) are collected, filtered, and thinned. A stroke is identified by such clues as sequence of directions, corners, and end-point location, and also by contextual clues when necessary. Multiple stroke symbols are recognized by the identification and relative location of the constituent strokes, regardless of the order in which they are written. The pen track is displayed until the character is recognized, and is then replaced by a standard hardware-generated version of the character. Previously written material remains on the display until removed. Changes, insertions, and deletions are easier than with pencil and paper. Experiments with groups of programmers, engineers, and secretaries indicate that a half-hour training period is sufficient, with 90 percent immediate recognition by the system. The scheme is in daily use in an experimental problem solving system at Rand. 59 pp. Ref.

RM-5028-PR JOSS: Arithmetic and Function Evaluation Routines. I. D. Greenwald. September 1966.

A description of the programming of arithmetic and function evaluation routines for JOSS from a programmer's point of view. JOSS functions are divided into three groups: arithmetic operations (including exponential and square root), elementary transcendental functions, and number dissection functions. The four arithmetic operations (add, subtract, multiply, divide) and square root treat the operands as exact nine-digit numbers and produce true results rounded to nine digits. Descriptions of the arithmetic routines are presented in gross verbal flow-charts, amplified by commentaries. The discussion of the transcendental functions emphasizes the analysis done to achieve almost nine-significant-digit accuracy in the results and shows how special cases are handled to hit certain "magic" values on the nose. Program flows of the number dissection functions demonstrate how a sophisticated tool may be supplied to the user with trivial expenditure of programming effort. 51 pp. (See also RM-5058.)

RM-5044-PR JOSS: Console Service Routines (The Distributor). I. D. Greenwald. September 1966.

A description of the function of the JOSS distributor, which handles all input and output from the user stations and teletypes. A major design criterion was to prevent "stare-down," a condition in which the computer and a console may be waiting for each other. The distributor makes certain that each console is in the appropriate state, transmits and encodes all input and output, keeps all lines within allowed lengths, ensures that characters are not lost during carriage returns and page changes, and sees that upper or lower case is printed according to user's typewriter shift. When the console is turned off, the distributor disables the station while the monitor "tidies up," and then enables it for the next user. An Appendix contains program documentation, consisting of a Station Control Register table and the nine console service routines. 34 pp. (See also RM-5058-PR.)

RM-5058-PR JOSS: Introduction to a Helpful Assistant. C. L. Baker. August 1966.
A step-by-step demonstration of JOSS--a system designed to provide the individual scientist and engineer with a personal computational service immediately available, whenever required, in his own working environment. The distinguishing features of JOSS are: mobile consoles equipped with electric typewriters for input and output; highly readable and powerful language for numeric computation; English capitalization, spelling, and punctuation rules; easy editing; quick response; exact input; familiar decimal arithmetic; exact output; and report-quality formatted output. The intimate interaction between man and machine permits the JOSS user to exercise judgment continually during the course of computation, changing and modifying the procedure as he wishes. This is one of the unique aspects that distinguishes JOSS from other systems and has led to its enthusiastic adoption by the RAND staff. This talk was presented to the Eleventh Annual Data Processing Conference at the University of Alabama Birmingham Center on 4 May 1966. 50 pp.

RM-5081-PR A Compact Statistical Method of Topographic Representation. B. W. Boehm, J. E. Rieber. February 1967.
An information regeneration method embodied in a FORTRAN program for storing topographic maps in a digital computer in compact form. A statistical model of the terrain is used. The major outlines of the topography are entered directly. When the altitude of any point is desired, the interstices are "fleshed out" by regeneration from the probability distribution of altitude variations, thus trading computer storage for execution time. Any desired degree of realism can be achieved at increased space/time cost. If realistic representation of a particular area is needed for detailed analyses of the influence of terrain, the direct representation methods described in RM-4636 are recommended. The statistical method is preferable for broad-brush analyses, in particular for terrain variation in a Monte Carlo analysis. 67 pp. Ref.

RM-5085-PR A Computer System for Inference Execution and Data Retrieval. R. E. Levien, M. E. Maron. September 1966.
Describes the Relational Data File, a computer-based data retrieval system now partly operational, capable of storing millions of facts and of retrieving data both directly and through logical inference. A large collection of information about cybernetics research was used as the data base. Facts are stored in the form of sentences in an artificial information language, each representing a binary relationship between two entities. Data are entered by means of special input forms; a translation program in a special programming language, FOREMAN, derives the relational sentences that are then internally coded and stored in the data file. An intensional file that stores facts about relationships permits many data sentences to be derived when needed, rather than stored explicitly. Counting space for all auxiliaries, one IBM 1301 disk holds 232,000 sentences in the information language. The system operates on an IBM 7044 computer. 35 pp. Ref. (See also RM-4793.)

RM-5108-1-PR Russian-English Dictionary of Cybernetics and Computer Technology, Second Edition, Revised and Enlarged. W. B. Holland. February 1969.
The second edition of the Rand Russian-English Dictionary of Cybernetics and Computer Technology contains over 300 new major entries, making a total of 2050 major entries and about 3300 subentries; each subentry defines a key term as it appears in frequently encountered phrases and special constructions. Many corrections and improvements to the previous definitions have been made. As before, entries are made for terms encountered in the Soviet cybernetic literature, without any attempt to define the field or to assemble a complete glossary. The dictionary is entirely machine-processed from punchcards and magnetic tape, and is photoreproduced directly from computer printout. 261 pp. (MW)

RM-5129-PR Programming by Questionnaire: How to Construct a Program Generator. P. M. Oldfather, A. S.

Ginsberg, H. M. Markowitz. November 1966.
A reference manual for the Programming by Questionnaire technique, presented in sufficient detail to enable a programmer to construct a program generator. Familiarity with the content of RM-4460 would be helpful to the user, and a knowledge of SIMSCRIPT is mandatory. The forms, use, and operation of the four components of the program generator are described in detail. A summary of technical details and complete Editor program listing are included as appendixes. 153 pp.

RM-5135-PR Soviet Cybernetics Technology: VII. ALGEC--Report on an Algorithmic Language for Economics Calculations (Preliminary Version). Translated from the Russian by W. B. Holland, J. B. Gazley. September 1966.
A working version of an expansion of the international high-level computer language ALGOL 60 to meet Soviet economic planning needs. A committee headed by M. A. Korolev was directed by the Soviet government to create such a language. ALGEC converts ALGOL 60 for use with the Cyrillic alphabet, provides for handling text, editing, list processing, and for access to individual items on lists and arrays. The Rand translators of the Russian draft show all changes from the original ALGOL 60. ALGOL conventions ignored by the author have been restored, and ambiguities clarified. Definitions of terms and syntactic units have been indexed. Russian-English and English-Russian glossaries of all ALGOL and ALGEC terms and an annotated bibliography of 12 Rand publications on Soviet cybernetics technology are appended. 158 pp.

RM-5136-PR Soviet Cybernetics Technology: VIII. Report on the Algorithmic Language ALGEC (Final Version). Translated from the Russian by W. B. Holland. December 1966.
A translation of the final version of the new Soviet Algorithmic Language for Economics Problems (ALGEC), a general-purpose computer programming language that can use both Latin and Cyrillic alphabets and either Russian or English reserved words. Based on ALGOL 60 and SUBSET ALGOL 60, ALGEC has been modified to permit the handling of tables, records, indexes, and documents of complex format and variable length; and to provide a means of selecting and processing individual items from such documents and from nonnumerical textual matter. Ideas and input-output procedures were taken from COBOL-61. The memorandum includes a translation of M. Korolev's article on the development of ALGEC; a brief biographical note on the Russian authors and editor; a Russian-English glossary of ALGEC terminology; and an English-Russian glossary included in an index to definitions of terms and syntactic units. A bibliography of Rand publications on Soviet cybernetics and computer technology is appended. 152 pp.

RM-5150-PR A Simple Scheme for Formalizing Data Retrieval Requests. F. M. Tonge. May 1967.
A description of an experimental scheme for translating data retrieval requests, expressed in reasonable "natural" language, into a formalized format. The simple translation procedure, which immediately feeds its proposed translation back to the analyst, uses rules depending on the position of words in the request and simple semantic information about the class of words. It is programmed in a list processing language (IPL-V) and is oriented toward a relational file organization. The present scheme is designed to process a single request rather than a dialogue of requests and retrievals. Also, the translation procedure is not yet coupled to a retrieval process. 38 pp. Ref.

RM-5157-PR Soviet Cybernetics Technology: IX. ALGEC--Summary and Critique. N. Wirth. February 1967.
A summary and evaluation of the preliminary and final versions of ALGEC, the Soviets' Algorithmic Language for Economics Problems. A computer programming language for economics data processing, ALGEC is an almost pure extension of ALGOL 60. The deletions are in conformity with the IFIP-approved SUBSET ALGOL. The extensions add features obviously needed to handle nonnumeric data. While not a complete list processing language, ALGEC appears to be adequate for business data processing, with the possible exception of decimal arithmetic. Also, input-output transfers cannot be identified by source. The retention of nested strings from ALGOL is an unnecessary complication, and the use of COBOL-style data structures (lists) precludes the handling of data with complex and dynamically varying relationships. Definitions lack precision, and the semantic and syntactic rules are unrealistic. 51 pp. (See also RM-5135, RM-5136.)

RM-5162-PR Programming by Questionnaire: The Job Shop Simulation Program Generator. P. M. Oldfather, A. S. Ginsberg, P. L. Love, H. M. Markowitz.

July 1967.
A description of the Job Shop Simulation Program Generator, an application of the Programming by Questionnaire technique developed at RAND to reduce the cost and time required to produce large computer programs, particularly those required for simulations of portions of the Air Force logistics system. The user can obtain a computer program by filling out a multiple-choice questionnaire covering aspects of the job shop he wishes to simulate. Answers are punched on seven cards that are fed to the program generator, which checks the answers for consistency, generates the program, and produces the data specifications. The user then completes the data deck according to the specifications, adds it to the end of the program deck, and submits the entire program to the computer. The output consists of interim reports on resource utilization, job statistics, and queue statistics, and a final summary report. The functions of the various routines and the meaning of the variables in the SIMSCRIPT definition deck are given for the use of SIMSCRIPT programmers. 115 pp. Refs.

RM-5183-PR The Application of On-Line Graphical Techniques for Programming and Operating a "Moving Network" Monitoring Display. L. Chesler, R. Turn. January 1967.
Describes the structure and operating procedures of experimental computer programs used to simulate a real-time moving network display of spacecraft checkout operations. Proposed in RM-4678 for use by the human monitor of an automated prelaunch checkout, the system dynamically shows, in network form, the successive and concurrent stages of a complex process. The programs were written in MAP for the IBM 7040/7044 computer system to be used with the RAND Graphic Input Tablet and a cathode ray tube display screen. The Tablet is used for on-line construction of the initial network and for operation of the simulation programs. (A complete program listing is available on request.) 98 pp. (See also RM-4122.)

RM-5216-PR JOSS: User Scheduling and Resource Allocation. G. E. Bryan. January 1967.
A detailed description of the monitor, the supervisory unit that exercises overall control of the JOSS system's operation. The monitor acts as a scheduling, resource-allocating, and synchronizing device, deciding priority and ensuring that all data and hardware necessary for a particular action are simultaneously available. This memorandum covers the priority queue structure, the hardware components comprising the JOSS environment, and instructions for operations of the JOSS system. 98 pp.

RM-5217 PR JOSS: Accounting and Performance Measurement. G. E. Bryan. June 1967.
A description of those portions of the monitor, the JOSS system's supervisory unit, that produce accounting records for charging functions and that gather performance statistics descriptive of typical user operation, over-all system usage, and machine performance. Charges for JOSS usage are based on the product of machine time and core space required plus the product of space and time required for long-term storage of programs and data on the disc file. Charge units are accumulated during JOSS operation and recorded on magnetic tape. The reports produced from the tape records record charges and other characteristics of individual JOSS sessions and the total usage both by department number and by project number. Much of the code and storage in the JOSS system is devoted to recording the occurrence of events that will help determine the system's performance and its operating environment. Certain data are displayed each minute on the JOSS master console, and other more global data are recorded in memory and displayed every four hours. The four-hour summary is periodically reduced by a JOSS program to give profiles of both the system's over-all operation and of the characteristics of individual usage of the system. 69 pp. Bibliog.

RM-5218-PR JOSS: Console Design. C. L. Baker. February 1967.
Describes the development at Rand of a remote typewriter console for use with JOSS, Rand's personal on-line computing service, and demonstrates the extreme care that must be taken to design an acceptable console for personal use by casual users. The input/output version of the familiar IBM Selectric was selected as the central element of the console because of its excellent keyboard feel, its high-quality output at a speed of 150 words per minute, its compact size, and its relatively low noise level. Primary considerations in the design of a console to house the typewriter included dimensions required for operator comfort and convenience, console mobility, the projected number of required electronic components and their packaging, and the incorporation of the associated switches and indicator lights in a small auxiliary con-

trol box. Discussion of the physical console is followed by an overview of the logic required to enable the user and JOSS to share the typewriter productively in an interactive conversation. Finally, a detailed description of this logical design is given in hardware terms. 125 pp. Ref. Bibliog.

RM-5220-PR The JOSS Primer. S. L. Marks, G. W. Armerding. August 1967. Introducton to JOSS, RAND's time-shared computing system, for the beginning user with examples illustrating the system's basic elements, which can easily be learned without programming experience. Seated at a mobile console connected to a computer via telephone lines, the Primer reader follows the instructions step by step, duplicating examples, trying variations, and observing results. He types commands in imperative English sentences, instructing JOSS to perform procedures in arithmetic, algebra, trigonometry, and logic. JOSS responds with answers in user-prescribed formats and with error messages that help the user correct errors and resume processing. To extend the beginner's knowledge of JOSS, the Primer concludes with lists of JOSS commands and functions and suggested reading in the JOSS literature. 44 pp.

RM-5257-PR JOSS: Disc File System. I. D. Greenwald. February 1967. Describes the user program and data storage system of JOSS, Rand's personal, online, time-shared computing service, in order to provide maintenance personnel with program documentation for the correction or modification of file-handling routines. The JOSS filing system provides the user with a service that will save him from retyping frequently used programs and/or data. It will also supply a limited program-chaining capability. Since this type of service implies low user demand for file action in terms of total session time, there is little concern with the time to service such demands. On the other hand, the amount of primary storage occupied by the file-service routines and associated core buffers is of considerable concern. 43 pp. Bibliog.

RM-5264-PR Computer Aids for Aerospace Design and Engineering: Innovation, Economics, and Public Policy. C. P. McLaughlin. July 1967. A discussion of the applications of computer systems to the weapons systems development process, with emphasis on the role that the government might play in promoting, supporting, and implementing development of new computer-based systems for engineering support in the aerospace industry. Potential payoffs to the government lie in reduction of design costs, improvement of design and product performance, enhancement of engineering creativity and productivity, and reduction of lead time for design, prototype production, and final production. A number of alternatives are open to the government in increasing the rate of development and diffusion of computer technology in industry. To determine the level and nature of such support, it is recommended that a study be made of the specific economic benefits that would result. 60 pp. Refs.

RM-5270-PR JOSS: Central Processing Routines. J. W. Smith. August 1967. A reference guide for JOSS users to (1) the language used for couching instructions to JOSS; (2) JOSS's responses to instructions; (3) the collection of machine-language routines (in JOSS's central computer) responsible for interpreting and responding to instructions; and (4) the details and decisions that bilaterally influenced the language and the design and implementation of the routines. The myriad details of total system design are given constant exposure, and particular emphasis is placed on the delicate balance and symbiosis that must exist among system, language, computer, and routines and on the pervasive effects of each component on the others. The material is presented in a narrative form, augmented by flow-chart representations of most of the principal routines, and is in part designed to serve as prolegomena to the annotated machine-language listings of the routines (copies of which are obtainable from RAND). 190 pp. Bibliog.

RM-5288-1-PR Digital Computer Simulation: The Allocation of Computer Time in Comparing Simulation Experiments. G. S. Fishman. October 1967. An improved step-by-step procedure for minimizing the computer time needed to obtain a specified statistical precision in the comparison of simulation experiments. The simulations are considered as covariance stationary stochastic processes, as explained in RM-4393. Well-known time-saving methods for reducing variance by inducing positive correlations between the experiments and high negative correlations between replications are included in the procedure. Results show that for a given level of accuracy, significantly less computer time is required when sample sizes are determined by the method suggested in the study than when they are equal. Also, small differences in the autocorrelation functions are important when each process is highly correlated. The suggested two-stage procedure provides initial estimates for determining sample sizes and final estimates for testing hypotheses. Graphical analysis suggests that the efficient allocation is not very sensitive to small errors in the estimates of population parameters. 32 pp. Ref.

RM-5290-ARPA Dataless Programming. R. M. Balzer. July 1967.
Preliminary specifications and an example program of the Dataless Programming Language. Based on PL/1 syntax, this high-level computer programming language shares many features with APL, some with COBOL, and uses the "bug" (pointer) of L6. Basically, the program is a set of specifications of manipulations to be performed on a set of data values without regard to the details of data representation, accessing, space requirements, etc. These are handled in a separate phase of data declaration. All data and function statements are expressed in one simple, canonical form. Changing the data representation has no effect on the source program; thus the data representation can be specified after the program is written. Facilities are provided for handling arrays, lists, double lists (with forward and backward links), rings, double rings, structures, and structures of other structures, such as arrays of lists of structures. Other data representations can be used by providing the necessary data handling algorithms, which may include calls to external programs written in any language. 52 pp. Ref.

RM-5322-PR JOSS: Problem Solving for Engineers. E. P. Gimble. May 1967.
A step-by-step demonstration of the basic principles of JOSS operation to enable engineers to solve progressively more involved problems in numeric calculation. Following an overview of the JOSS system, including descriptions of the console and language, examples of JOSS input and output demonstrate how the basic commands, both direct and indirect, are applied. Direct commands are used to solve problems when only a few answers are required, and indirect commands are used when many answers are required, when many variables are to be set, or when a number of steps must be performed in a prescribed sequence. Special JOSS techniques allow the user to choose between several acceptable commands, to minimize function arguments, and to direct JOSS to "dress up" output with headings and condensed printout. A filing system provides long-term storage for programs and data and eliminates the need for retyping frequently used material. The appendices include a list of legitimate JOSS commands, a description of the use of expressions and propositions, and a discussion of the available JOSS functions. 85 pp.

RM-5359-PR JOSS: 20,000 Hours at the Console--A Statistical Summary. G. E. Bryan. August 1967.
Results of the first year of JOSS operation on the Digital Equipment Corporation PDP-6. The gathering of data for revenue accounting and for producing performance measures of the JOSS system and its users is a major function of the monitor, the system's supervisory unit. As generated by the instrumenting programs, statistics on usage indicate that over 700 individuals make use of JOSS service. Every month 400 different users generate over 200 sessions each day. Typical user sessions last 45 minutes and average 4 minutes of computing time, although 50 percent last less than 7 seconds. During an average session, 15,000 JOSS statements are executed, and 68,000 arithmetic operations are performed. JOSS user requests are substantially different from those made on other time-shared systems: there are a relatively large number of requests for short amounts of computing and a relatively small number for a large amount of computing. The amount of computing, however, is by no means trivial, as seen from the number of statements and arithmetic operations performed. 45 pp. Refs. Bibliog.

RM-5367-PR JOSS Notebook. G. E. Bryan, E. W. Paxson. August 1967.
A loose-leaf reference guide for JOSS sophomores, who have had experience at a console and are familiar with the introductory JOSS literature (RM-5058-PR, RM-5220-PR, RM-5322-PR, RM-5377-PR). In addition to the basic tutorial material on JOSS language, commands, and functions, practical instructions are given on how to insert paper and change ribbons; typewriter settings; procedures for contacting JOSS; and actions to take in the event of console, line, or machine malfunction. Twelve annotated sample programs are included, together with an index that complements the heavy cross-referencing used throughout the notebook. In contrast to the more technical JOSS publications,

these notes generally eschew detailed discussion in favor of informal interpretation and exemplary material. 157 pp. Bibliog.

RM-5377-PR JOSS Language. G. E. Bryan, J. W. Smith. August 1967.
A JOSS user's portfolio containing three brief reference summaries of the actions that can be requested of JOSS and of the language for requesting these actions. The summaries are presented in varying formats to suit the user's convenience: a pocket-size book for personal use (Pocket Precis, 17 pp.), a larger and more complete piece for desk-top or console use (Apercu and Precis, 23 pp.), and a poster-size summary for the bulletin board (Poster Precis, 1 p.). The precis demonstrate that the language provided for JOSS is terse, unambiguous, and readable, stressing familiar English terminology and punctuation and with relatively few rules governing correct use. The speed and ease of interaction between JOSS and the user, the simplicity of the language, the use of familiar decimal arithmetic, and JOSS's precise error and status reporting combine to allow most problems to be solved by an understanding of the problem at hand and a list of JOSS commands and functions.

RM-5424-PR A Survey of Soviet Work in the Theory of Computer Programming. R. A. DiPaola. October 1967.
A critical survey of Soviet efforts to develop a mathematical theory of computer programming and automatic programming methods (PP or programming programs). The study traces the development of the "operator" theory of A. A. Lyapunov and his associates from its starting point in program schemes designed to represent specific problem-solving algorithms to its algebraic formulation in terms of the theory of categories. Other authors have attempted to adapt graph theory and the theory of algorithms to the construction of better programming languages. In contrast to FORTRAN, the practical result of PP has been to raise, rather than lower, the level of technical knowledge required for programming. Current Soviet research is directed toward adaptation and extension of ALGOL 60 rather than further theoretical work. Some of the Russian work, however, may be of practical relevance, particularly Glebov's synthesis of operators from measurably simpler ones. 144 pp. Refs.

RM-5428-PR Answering Questions by Computer: A Logical Study. J. L. Kuhns. December 1967.
A study of the processing of questions input to a computerized question-answering system such as the Rand Relational Data File (see RM-5085). The process consists of (1) transforming the natural-language question into a symbolic question (i.e., a certain formula of predicate calculus) and (2) generating the answer by calculating the value set of the resulting formula. This study is addressed to the second step. A key problem is the identification of "reasonable" input queries. These are characterized by introducing the concept of definite formula. A particular class of definite formulas--the proper formulas --is especially suitable for machine processing. A set of machine-recognizable sufficient conditions for their identification is given, together with rules for calculating their value sets. The definite, but improper, formulas are also studied. It is shown that definite formulas without quantifiers can be transformed into proper equivalents. For definite formulas with quantifiers, limited but useful results are obtained. 137 pp. Ref.

RM-5437-PR JOSS: Assembly Listing of the Surpervisor. G. E. Bryan. August 1967.
A presentation of the code for the monitor (supervisor) unit of JOSS, RAND's on-line, time-shared computer system. This unit, which acts as a scheduling, resource-allocating, and synchronizing device, exercises overall control of the system's operation. It ensures that all data and hardware necessary for a particular action are simultaneously available, and meters the operation of the system to provide revenue accounting information and data describing system performance and user operations. 193 pp. Bibliog.

RM-5495-PR/RC The Problem of Privacy in the Computer Age: An Annotated Bibliography. A. Harrison. December 1967.
A selected, annotated bibliography of more than 300 publications pertaining to all aspects of the problem of privacy in the computer age. A few publications, though not directly relevant, are included because they describe systems with obvious implications for privacy (e.g., computer time-sharing systems, computer utilities). Most of the entries are for the years 1965-1967, but some earlier items of lasting importance are also listed. The memorandum is divided into three parts:

(1) an essay overview of the problem of privacy and the computer; (2) the bibliography, in which the annotated entries are listed alphabetically by author or (if anonymous) by title; and (3) an index of all entries alphabetically listed under one or more of 14 subject categories (e.g., Data Banks, Legal and Law Enforcement View of Privacy). If a publication has not been reviewed, it is included but not annotated. In some entries (particularly newspaper articles) derived from clippings, certain facts of publication are lacking. Since most discussions pertaining to the right of privacy refer to the Bill of Rights, an appendix provides the full text of Amendments I-X of the Constitution. 134 pp.

RM-5495/1-PR/RC The Problem of Privacy in the Computer Age: An Annotated Bibliography, Vol. 2. A. Harrison. December 1969.
A listing with abstracts of more than 300 items pertaining to all aspects of computer security and privacy published mostly in the years 1967-1969. The overall introduction is reprinted from the first volume, and there is also an overview of the situation reflected in the second volume. The problem is attracting an ever-growing amount of attention both here and--now --abroad, while enormous amounts of personal information about individuals continues to accumulate in thousands of large files. The credit industry, increasingly powerful in its effect on people's lives (employability, insurability, credit worthiness) maintains almost complete anonymity and is virtually unregulated. As a result of an investigation by Congressman Gallagher's Subcommittee on Invasion of Privacy, the Associated Credit Bureaus issued Credit Bureau Guidelines to Protect Consumer Privacy. Senator Proxmire's Fair Credit Reporting Act was passed by the Senate. Reflecting new emphases in the literature, two new subject headings have been added to the cumulative subject index--Privacy Concern in Foreign Countries, and Religious Concern and Privacy. 157 pp. (MW)

RM-5531-ARPA The Integrated Graphics System for the IBM 2250. G. D. Brown, C. H. Bush. October 1968.
A programmer's manual for IGS, the Rand interactive computer graphic software, as implemented on the IBM 2250 graphic hardware. Programmed in FORTRAN IV with special facility for addressing a single character directly. IGS is machine-independent and callable from many languages acceptable to an IBM 360, including PL/I. The 360 can only start or stop the 2250 and read or write into it. The user controls the system through the 2250's online typewriter, light pen, or function keys; or by writing or drawing on the RAND Tablet, if included; or by touching user-defined sensitive areas with the light pen or Tablet stylus. Only parameters of interest need to be specified; IGS automatically provides default values for character size, spacing, line spacing, and other format details. IGS accepts user coordinates and translates them into raster units. It automatically rescales graphical data to fit available space, converts graphical to numerical data, etc. One subroutine draws an entire graph to fit given data, with a single call. The RM includes an alphabetical index, a cross-reference index of subroutine calls, and a listing by type, as well as a detailed description of each. 175 pp. Ref. (MW)

RM-5550-ARPA Real-Time Recognition of Handprinted Text: Program Documentation. G. F. Groner. May 1968.
Documentation of an IBM/360 assembly language program for on-line graphical-input character recognition using the RAND Tablet. The program is written as a reentrant process and requires about 3700 32-bit words of storage. The user must provide his own programs for communicating with the Tablet and CRT display of symbols. The program recognizes handprinted letters, numbers, punctuation marks, and geometric figures; it separates characters written in quick succession and in close proximity. As the user writes on the Tablet, the program tests the positional data for directions, corners, position, maxima and minima, and relationship to previous strokes. When a set of strokes is recognized as a character, its stylus track is replaced on the CRT by a neat standard version. About ninety percent of the characters are recognized correctly by the program; correction by the user is easy. The Memorandum consists mainly of the program printout, with extensive internal commentary. Directions are appended for using the program with the standard IBM OS/360 operating system and 2250 CRT display unit. 186 pp. Refs. (See also RM-5016-ARPA.)

RM-5551-PR Soviet Cybernetics Technology: XI. Homogeneous, General-Purpose, High-Productivity Computer Systems--A Review. H. Barsamian. April 1968.
A review and evaluation of the first

Soviet book entirely devoted to problems of high-productivity computing systems. Published in late 1966, the book reports on studies conducted at the Institute of Mathematics in Novosibirsk. Since the Soviet system of national economic planning requires a volume of coordinated, relatively simple calculations, and Soviet computer technology does not equal that of the West, the authors, E. V. Evreinov and Yu G. Kosarev, have sought a way to increase computer productivity without greatly increasing technological demands. Their solution is parallelism: the coupling of 1000 computers, each capable of a million operations per second, so that all work together on the same program at the same time. However, the authors have not succeeded in establishing a new approach based on parallelism that will solve the problems of increased productivity, nor have they made a convincing case for their basic assumptions. The proposed linking of 1000 branch computers to achieve the desired running speed is not feasible, nor is the use of homogeneous computing media to develop the microstructure of a system. Methods of controlling and monitoring parallel algorithms are not considered. Although all theoretical conclusions were supposedly verified on the experimental Minsk-222 system, the actual results are not documented and there is no clear description of the operations performed. 33 pp. (For translated excerpts, see P-3600/5.)

RM-5561-PR A Zero-One Programming Approach to Scheduling with Limited Resources. A. A. B. Pritsker, L. J. Watters. January 1968.

A zero-one linear programming formulation of scheduling problems that is more versatile and efficient than any other known LP formulation. It is the first formulation designed to accommodate multiple resource constraints. Bowman's formulation can be extended to do so, but in a sample comparison, it required 72 variables and 125 constraints for a 3-project, 8-job, 3-resource problem compared with 33 variables and 48 constraints for the new formulation. The new method also showed substantial improvement when compared with schedules based on two common dispatching rules: first-come-first-served and earliest-completion-date. Execution time on Rand's IBM 7044, using the Geoffrion computer code (see RM-4783), was 3 seconds. Other objective functions are formulated in the study and additional constraints are modeled. Examples of larger problems rewritten for standard LP computer codes showed that the number of variables and constraints involved are probably within no more than one order-of-mangnitude of the maximum number that could be handled with available zero-one computer codes. 59 pp. Refs.

RM-5587-PR Soviet Cybernetics Technology: X. Bibliography of Literature Cited in 1964 Issues of the Journal of Abstracts--Cybernetics. Edited by W. B. Holland. February 1968.

A listing, by author, of all the publications of Soviet origin, or published in the Soviet Union, that were abstracted in the 1964 issues of the Referativnyu zhurnal--Kibernetika, a monthly publication of the All-Union Institute of Scientific and Technical Information under the Academy of Sciences of the USSR. (The abstracts are not included.) The coverage reflects the extremely broad meaning of "cybernetics" in Russian: it is applied to mathematical and computational techniques and to all forms of information, communication, and control, including programmed instruction and neurophysiology. Works in seven languages are included. All entries have been translated into English. A complete citation is given under each author of a joint work. A list of 55 Soviet publishing houses and 185 titles of journals were extracted from the citations. A bibliography of Rand Publications on Soviet Cybernetics and Computer Technology is appended. 303 pp.

RM-5611-1-ARPA APAREL--A Parse-Request Language. R. M. Balzer, D. J. Farber. September 1969.

A description, without listing, of APAREL, a flexible high-level parsing-language extension to PL/I that has been used in a translator for Dataless Programming (RM-5290), a powerful syntax and function macro system, and an on-line command parser. Parse requests are stated in a BNF-like format with special sequencing rules. On successful completion, an associated piece of PL/I code is executed, using as data the success or failure of the alternative parsings, and as strings the various elements of the parse at all levels. APAREL includes parse-time semantic checks and facilities for multiple input-output streams. The initial implementation on the IBM 360 comprises (1) a preprocessor that converts APAREL programs into legal PL/I programs, and (2) the run-time parser, which is written in assembly language. APAREL provides the pattern-matching capability normally found only in special-purpose languages such as SNOBOL4 and TMG. 38 pp. (MW)

RM-5618-PR DISPLAY--A Guide to the TRACK FORTRAN Debugging System. D. C. MacNeilage. May 1968.
A guide and working example of TRACK, a FORTRAN program designed by Robert L. Mercer of Kirtland Air Force Base to aid in the debugging of other FORTRAN programs. TRACK follows all, or selected parts, of the execution of a program step by step and copies the result of each step onto an output file tape (TAPEQ). The tape retains the original program name and may be compiled and executed as any other FORTRAN program. TRACK employs extended USASI FORTRAN language as used in the Control Data 6000 series computer systems. The guide is in the form of an internally documented program, DISPLAY, for input to TRACK. The Memorandum consists almost entirely of a punched-card listing and execution output: (1) a source deck listing of the DISPLAY program; (2) the execution output of the tracked program DISPLAY; (3) a source deck listing of the TRACK program output. The study constitutes part of a continuing effort to enlarge upon a source library of programs coded entirely in FORTRAN and designed for FORTRAN diagnostic and service use.
43 pp.

RM-5654-PR The History of the JOHNNIAC. F. J. Gruenberger. October 1968.
A description of the development and use of the Rand-built JOHNNIAC computer, which spanned the first decade of the computer industry. In 1950, Rand decided to build its own computer, partly on the advice of John von Neumann (for whom JOHNNIAC was named) to change from 604 wired programming to stored programming, and partly from the lack of suitable commercial machines. In design, JOHNNIAC was a Princeton-class machine. It became operative in mid-1953, and although commercial machines gradually superseded the range of JOHNNIAC's capabilities, it had high reliability and was used until early 1966, when it was retired to the Los Angeles County Museum. Besides numerous contributions to the programming art, achievements deriving from JOHNNIAC are the RAND Tablet and JOSS. Appended are a memorandum from John Williams, then head of Rand's mathematics department, urging retention of JOHNNIAC despite the reported superiority of the new IBM 701; and the definitive "Preliminary Discussion of the Logical Design of an Electronic Computing Instrument," by Arthur Burks, Herman Goldstine, and John von Neumann. 143 pp. (CD)

RM-5660-PR The Integrated Graphics System for the S-C 4060: I. User's Manual. G. D. Brown, C. H. Bush, R. A. Berman. December 1968.
A description of the S-C 4060 version of Rand's Integrated Graphics System (IGS), a machine- and device-independent software package. The S-C 4060 stored-program graphical recording system consists of a small special-purpose computer, called the Product Control Unit (PCU); a high-precision cathode ray tube (CRT); a camera; a film developer; a hardcopy unit. IGS is programmed in FORTRAN IV, with special facilities for manipulating a single character in any position. IGS can be called by programs in FORTRAN, PL/I, and SIMSCRIPT, as well as machine language. On command, it draws lines and circles, plots points, composes text and tables with headings, and creates linear or nonlinear graphs. One subroutine draws an entire graph to fit given data, with a single call. Only parameters of interest need to specified; IGS automatically provides default values for character size, spacing, line spacing, and other format details. IGS accepts user coordinates and translates them into internal units. It automatically rescales graphical data to fit available space, and converts graphical to numerical data.
118 pp. Ref. (MW)

RM-5661-PR The Integrated Graphics System for the S-C 4060: II. System Programmer's Guide. G. D. Brown, C. H. Bush, R. A. Berman. January 1969.
A guide for programmers seeking to (1) modify or extend IGS as implemented for S-C 4060, (2) convert IGS for other machines, or (3) design their own character fonts for use with IGS. Directions are given for converting a designed character into its vector-string representation, which the system will convert into data cards that may be stored in a program library or loaded with an individual IGS job. The vector-string characters are unrestricted as to size, shape, or orientation. IGS performs for these vector characters all the functions the 4060 performs for its CHARACTRON set--display, character spacing, line spacing, tabbing, margination, and automatic adjustment to accommodate changes. Special debugging routines are provided to test whether a font looks and performs as intended. The memorandum includes a listing of the mode sets; the METAZZ call and metalanguage string used to achieve each of the IGS capabilities; a cross-reference list of the subroutines that call each other; core storage requirements; and directions for use with PL/I programs, as well as a description of each individual system subroutine. The graphics subroutines are described in RM-5660, which

also describes the S-C 4060 and the relationship between IGS and the S-C 4060. 108 pp. Refs. (MW)

RM-5689-PR Programming by Questionnaire: Auxiliary Programs. P. L. Love, P. M. Oldfather. August 1968.
Description and listing of five small SIMSCRIPT and FORTRAN programs to complete the documentation of Programming by Questionnaire, a technique for reducing the time and cost [illegible] preparing large computer programs. Three housekeeping programs, CHKOUT, LOCATE, and KORCT, serve to check, correct, and maintain the program generator deck. The CHKOUT program checks the deck for logical consistency and provides other information essential for correcting and maintaining it. The LOCATE program finds specified cards within the deck, which is very large. The KORCT program makes corrections to the deck and checks to see that it is in order. The JHIST and RHIST programs analyze the results of a JSSPG simulator. JHIST provides a complete history of the jobs in the simulated job shop, and RHIST provides a history of the resources. 83 pp. (See also RM-5162.)

RM-5709-PR A Computer-Driven Stereo Display for Aerial Maneuver Analysis. R. Turn, H. E. Petersen. October 1968.
A description of an on-line interactive stereoscopic display system for three-dimensional visualization of trajectories of maneuvering aircraft. The system is constructed by equipping an IBM 2250 display unit with a stereo-viewing device and using the IBM 360/40 computer to generate stereo pairs of the desired trajectories from punchcard data showing u, v, w coordinates of the aircraft at specified points in time. A display capacity of 900 points may be divided between as many as three separate trajectories. By pressing buttons or typing in new parameters, the user can (1) order views from front, rear left, right, above, and below; (2) rotate the display as desired; (3) zoom in or out to magnify or reduce the images; (4) generate trajectories dynamically in real time; (5) change any parameter and observe the effect; (6) use the CONTRAIL mode of selective plotting to avoid real-time flicker, or confusion when many points have been plotted; (7) order hardcopy tapes for S-C 4060 execution yielding 35 mm film-strip and Xerox prints. Numeric information, such as elapsed time and slant range, is displayed and updated continuously. 58 pp. Ref. (MW)

RM-5772-ARPA EXDAMS--Extendable Debugging And Monitoring System. R. M. Balzer. April 1969.
A description of EXDAMS, an on-line system designed to facilitate experimentation with new debugging and monitoring aids for higher-level computer languages. Instead of the usual manipulation of the source program while it runs, the EXDAMS system constructs a model of the program structure and a history tape of its operation containing all the control flow and variable-alternation information, after which no further interaction with the source program is required. The model serves to associate each value in the history with the source statement that produced it. Together with the model and symbol table, the history tape is run and observed by the user at a CRT terminal. The user controls the execution speed and can run the program history forward or backward (for flowback analysis). He can stop at any moment and switch from one EXDAMS debugging/monitoring aid to another. EXDAMS was designed for flexibility and experimentation rather than efficiency; however, use of the model to interpret the history, rather than having the history be self interpretable, saves about half the input/output. 37 pp. Refs. (MW)

RM-5776-PR The SIMSCRIPT II Programming Language: Reference Manual. P. J. Kiviat, R. Villanueva. October 1968.
A compact reference listing of the syntax and semantics of SIMSCRIPT II, designed for professional programmers already familiar with the language. (SIMSCRIPT II is fully described in R-460, and its IBM 360 implementation in RM-5777.) The notation employed was chosen for convenience and descriptive power from conventions previously used in computer programming language descriptions. The study describes notation; basic constructs (symbols, primitives, metavariables); statements (non-executable, storage allocation, computation, control, input-output, simulation); system-defined values (constants, variables); a system-defined routine (the ORIGIN routine for simulation time); generated attributes, variables, and routines; and library functions. 32 pp. (MW)

RM-5777-PR The SIMSCRIPT II Programming Language: IBM 360 Implementation. P. J. Kiviat, H. J. Shukiar, J. B. Urman, R. Villanueva. July 1969.
A supplement to the user's manual (R-460), this memorandum describes the implementation of SIMSCRIPT II on Rand's 360/65 computer. The error codes issued during com-

pilation and during execution are listed and their meanings explained. The first section of this manual contains modifications to R-460 and can only be used in conjunction with it; it identifies the statements that are not yet implemented. Other sections give the rules and deck setup for compilation, assembly, and execution; ways to define additional data sets; calling assembler language routines; storage allocation during execution; random number generation and statistical functions; and directions for installing the compiler, including a listing of JCL that can be used to load the library, compiler, and assembly interface and to punch off the SIMSCRIPT II macros, distributed procedures, and sample program. 52 pp. (See also RM-5776.) (MW)

RM-5825-PR POGO: Programmer-Oriented Graphics Operation. B. W. Boehm, V. R. Lamb, R. Mobley, J. E. Rieber. June 1969.
A description of POGO, a fully operational system for easy interactive computer graphics programming. POGO is well suited to the interplay of computational programs with alphanumeric and curve input and display, though not to highly dynamic interplay with geometric manipulations. The POGO system includes: (1) A design program for composing control displays at the graphics console and interfacing them to a FORTRAN program. (2) A program to trace curves via the RAND Tablet into specified FORTRAN arrays. (3) A program to output curves from specified FORTRAN arrays onto the 2250 display screen. Development required one man-year with 100 console-hours. Once the user has designed his control pages by means of the RAND Tablet, he can press a button to punch out a set of cards that will recreate the display at any time. Although the design program and the curve-tracing program require the RAND Tablet, the rest of the POGO pages (including those composed with the design program) will run on a configuration having only a light pen and keyboard input. A glossary of computer graphics terminology is appended. 44 pp. Ref. (MW)

RM-5883-PR Digital Computer Simulation: Computer Programming Languages. P. J. Kiviat. January 1969.
A discussion of simulation languages, their characteristics, the reasons for using them, and their advantages and disadvantages relative to other kinds of programming languages. Simulation languages are shown to assist in the design of simulation models through their "world view," to expedite computer programming through their special purpose, high-level statements, and to encourage proper model analysis through their data collection, analysis, and reporting features. Ten particularly important simulation programming language features are identified: modeling a system's static state, modeling system dynamics, statistical sampling, data collection, analysis and display, monitoring and debugging, initialization and language usability. Examples of each of the four simulation languages, GPSS, SIMSCRIPT II, SIMULA, and CSL, are used to illustrate how these features are implemented in different languages. The future development of simulation programming languages is dependent on advances in the fields of computer languages, computer graphics, and time sharing. Some current research is noted, and outstanding research areas are identified. 110 pp. Ref. (MW)

RM-5925-NIH An Interactive Graphics Program for Studying Models of Kinetic Chemical Systems. G. F. Groner, R. A. Berman, R. M. Heirschfeldt. June 1969.
This interactive computer graphics system permits biologists to study models of kinetic chemical systems and computer scientists to investigate interactive modeling. The program runs on an IBM 360/40 computer and is intended to provide a convenient means of (1) describing a model via chemical equations; (2) observing the behavior of a model during simulation; (3) editing output formats and modifying the model. The user communicates with the computer via the RAND Tablet used in conjunction with a 2250/Model 1 CRT display device. The program has several desirable features: (1) It simulates multiphase chemical systems having both fast and slow reactions. (2) The user may enter chemical equations by printing them, as on a piece of paper, and the program displays its interpretation as a check. (3) The user can intervene in the simulation at any time, examine any reactant plotted on any linear scale against any other reactant or time, rescale curves, or delete them. (4) A reset capability permits backtrack for correction or to return a graph to a previous state. 62 pp. (MW)

RM-5937-PR A FORTRAN Programmer's Introduction to SIMSCRIPT II. H. J. Shukiar. March 1969.
This study is intended to introduce the FORTRAN programmer to some of the main concepts and features of the first three levels of SIMSCRIPT II--the levels which constitute an algebraic compiler. Emphasis is on the power and flexibility that

SIMSCRIPT gives the programmer. Among the distinctive features are (1) the SIMSCRIPT preamble; (2) the preamble statements, such as NORMALLY, DEFINE, DEFINE TO MEAN; (3) the fact that any number of conditional expressions can be executed if a logical condition is met; (4) the ability to reread the same records in different formats. Unlike FORTRAN, SIMSCRIPT passes argument values rather than argument locations between subprograms. The method of constructing arrays is radically different. The SIMSCRIPT programmer can conserve core storage, construct ragged tables, generate tree structures, and do list processing with relative ease, and his programs can be read rather than deciphered. 35 pp. (MW)

RM-5947-PR Relational Data File: Experience with a System for Propositional Data Storage and Inference Execution. R. E. Levien. April 1969.

An overview of the prototype Relational Data File, a computer data bank distinguished by the storage of data in a series of separate "atoms" of one binary relational sentence each, and the ability to retrieve data not explicitly stored that can be inferred from stored data. The prototype RDF contains 70,000 sentences extracted from scientific and technical source items. Each sentence is encoded in four 36-bit computer words, with synonyms automatically translated to standard form and ambiguities flagged for manual correction. New entries in the synonymy/ambiguity dictionary update all stored data. Each accepted sentence is quadruplicated and stored in four subfiles by each of the key elements. A string dictionary decodes entries for output. A special retrieval language, INFEREX, allows retrieval through any inference scheme that can be expressed in the predicate calculus and set theory. The RDF structure seems well suited for very large data bases where new types of data are continually being added and other types removed and where data are incomplete (as inrapidly changing fields), redundant, or unpredictable. 36 pp. Ref. (MW)

RM-5999-ARPA The GRAIL Project: An Experiment in Man-Machine Communications. T. O. Ellis, J. F. Heafner, W. L. Sibley. September 1969.

An interactive software-hardware computer-graphics system has been developed in which the displayed contents of a cathode ray tube (CRT) can be manipulated directly using a RAND Tablet and stylus. The design goals for this system were (1) to provide man-machine communication using only the CRT display and real-time interpretation of stylus motion, (2) to minimize ambiguous responses and make the operation apparent, (3) to make the system responsive with minimal distraction and delay, and (4) to make the system compete as a problem-solving aid. Computer programming via flowcharts was chosen to demonstrate the techniques. System responses on the CRT include location of the virtual position of the stylus, ink track representing its motion on the tablet, changes in display intensity, pictorial modification, and English-language statements. The important result of this investigation is the demonstration of feasibility of such an approach. This is the first part of a final report on GRAIL. 26 pp. Ref. (See also RM-6001, RM-6002.) (MT)

RM-6000/1-PR Soviet Cybernetics: Recent News Items, Vol. 3, No. 1. Edited by D. McDonald, W. B. Holland. January 1969.

The January 1969 SC:RNI, the first issue to appear in the RM series, features an article by Minsk Factory director V. Gol'dberg suggesting that Soviet computer producers be made responsible for the introduction, installation, servicing, and basic software of their products (at present, systems are often shipped unassembled). Another article discusses requirements for high-level compiler languages for engineering problems. Although 60 new journals have been added since 1966 and older ones enlarged, the backlog of unpublished results grows and lead time after submission averages 18 months. Academy natural-science journals will give at least one-fourth of their space to brief communications and annotations of reports that are not printed but deposited for request copying; institutes are urged to give authors editorial help and to distribute reprints. Also included: specifications for process control computers that are not met by present Soviet equipment; a cutaway view of the Soyuz-3 spacecraft; Georgian research on voice recognition; Armenian development of pneumonic (airjet) controls; demographic forecasting in the Ukraine; biographical sketch of radio scientist V. A. Kotel'nikov. The Academy of Sciences has translated into Russian the latest edition of the manual for the Norwegian simulation language, SIMULA. 73 pp. (MW)

RM-6000/2-PR Soviet Cybernetics: Recent News Items, Vol. 3, No. 2.

Edited by D. McDonald, W. B. Holland.
February 1969.
This issue features a brochure for the Mir, a small computer for scientific and engineering calculations that accepts alphanumeric and mathematical symbol input via on-line typewriter. A computer logic that can handle natural-language input without a translator is described in an article by Glushkov. A rental bureau for equipment needed only temporarily by scientific and educational institutions is discussed in a short article. Three articles and five short items are concerned with medical cybernetics, particularly space medicine. Reports by four high officials on automation and instrumentation, extracted from Supreme Soviet discussions of the 1969 economic plan, reflect a greater concern this year with automation and instrument construction. This is due to K. N. Rudnev's Ministry of Instrument Construction, Means of Automation, and Control Systems, which is more oriented toward instrumentation and office equipment than toward computers and large systems. Among other items are those on the use of computers in Ukrainian ferrous metallurgy; past and future conferences on industrial psychology, programmed instruction, and automata and artificial intelligence; and scientific organization of labor in Latvia. Articles on hardware include the Polish UMTS-10 computer; a new EDM-450 computer for processing network diagrams without programming; the Moscow automatic traffic control system; and five papertape readers. 112 pp. (MW)

RM-6000/3-PR Soviet Cybernetics:
Recent News Items, Vol. 3, No. 3.
Edited by D. McDonald, W. B. Holland.
March 1969.
This issue features an article on small computers and a progress report on the State Network of Computing Centers. Two articles, one popular and one technical, describe the planned Sirena-1 system for airline reservations. The system differs from Western systems in two respects: (1) It does not apply to all of Aeroflot's ticket sales and reservations, but only to the Moscow airport, with some tie-ins to other major airports for return flights to Moscow. (2) It provides automated printing for individual passenger tickets. A description of the computer science curricular and support activities of Moscow State University is provided by an article on the University Computer Center. Other items of interest include (1) a biography of Academician, Engineer-Admiral Aksel I. Berg, on the occasion of his 75th birthday; (2) a critique on how scientists spend their working hours; (3) an article on the Lvov Information Control System (designed by Glushkov for the Lvov TV Factory), which the Ukranian Academy of Sciences has ordered to be generalized for use in a wide range of factories engaged in mass production of a limited variety of products. 69 pp. (MW)

RM-6000/4-PR Soviet Cybernetics:
Recent News Items, Vol. 3, No. 4.
Edited by D. McDonald, W. B. Holland.
April 1969.
The April issue features an extended description of the BESM-6 hardware, software, and list of instructions; the computer does not appear well suited to the multiprogramming for which it was designed. Soviet game theory is described as similar in level to that of the United States, but is of different content. It has been applied successfully to control and productivity (often as a game against Nature, as in catching fish or planning transmission lines). In view of the shortage and inferiority of Soviet computers, a political economy faculty calls for hardware, software, and services similar to those of the capitalist states --if necessary, by licensing foreign patents. Other articles give criteria for installing automatic control systems; defend the usefulness of mathematical optimization methods; recommend forecasting of technical developments through the study of patents; report work on noncrystalline semiconductors used as vidicons; and describe medical applications of computers. 145 pp. (MW)

RM-6000/5-PR Soviet Cybernetics:
Recent News Items, Vol. 3, No. 5.
Edited by D. McDonald, W. B. Holland.
May 1969.
The May issue features an article on automated management information systems in which it is clearly indicated that the Soviet labor force is feeling the effects of automation. Three articles on forecasting show that prognostics is beginning to take hold in the Soviet Union and that it is being dealt with by some very prestigious scientists. Academician G. Marchuk's article on the centralized management of the computer industry reflects the thinking of Soviet leaders in computing about the USSR's needs, particularly relative to the importance of disc storage units. Hardware discussed includes the Ruta, and Masis, the M-54, and some East German machines. Other articles describe computer-assisted and computer-managed instruction in electrical engineering; automation of a heavy machine plant; conferences on industrial

and general psychology and on mathematical methods in geology and hydrogeology; research at Science City and Kiev; and development of the State Network of Computing Centers. 135 pp. (MW)

RM-6000/6-PR Soviet Cybernetics Review, Vol. 3, No. 6. Edited by W. B. Holland. June 1969.

The June issue initiates a new title for the former *Soviet Cybernetics: Recent News Items*. One article gives the first concrete evidence of a new direction in Soviet computers toward third-generation machines that are program-compatible with the IBM System 360; the M-1000, -2000, and -3000 are the first being developed. Other hardware discussed are the Ural-14, Razdan-3, BESM-4, Ruta-110, Minsk-22, -23, and -32 computers and the Robotron-300 high-speed data processing complex. One article concludes that a multimachine operating mode promises more efficiency than does multiprogramming. Several articles stress the importance of fitting computers for national economic planning and automated control systems. In an article on modeling artificial intelligence, the leading Soviet researcher on medical cybernetics points out that the creation of large-scale intelligence is only a matter of time. However, unless it is not an automaton but a personality, with a program of consciousness and imaginativeness, intelligence like man's cannot be approximated. 125 pp. (CD)

RM-6000/7-PR Soviet Cybernetics Review, Vol. 3, No. 7. Edited by W. B. Holland. July 1969.

This special issue is devoted to programming and programming languages. A revolution comparable to the FORTRAN II era in U.S. computing has been taking place in Soviet software, particularly in the development of algorithmic languages and translators. While ALGOL remains the basis of Soviet programming languages, interest is growing in FORTRAN, COBOL, and SIMSCRIPT, and local languages have been developed. New directions in Soviet computing are evidenced by trends toward large machines and third-generation (ASVT) computers that are compatible with the IBM Series/360; integration of hardware and system design; and new concern with man-machine interaction. Manifesting this heightened interest, the First All-Union Conference on Programming was held in November 1968. The issue contains abstracts of the papers presented and a full translation of a report on the use of automata theory in resolving problems in the man-machine interface. 120 pp. (CD)

RM-6000/8-PR Soviet Cybernetics Review, Vol. 3, No. 8. Edited by W. B. Holland. August 1969.

This issue includes two conference reports on the design program for ASVT modular hardware, and two articles discussing the causes of the time lag in implementing new technology. A summary of the Soviet view of writing programming languages is given in an article announcing the ALGOL 60-based ALPHA language, now used to compile BESM-6 code on the M-20 computer. The Recursive Functions Algorithmic Language (REFAL), used on the BESM-6, is also discussed. Articles on computer hardware include discussions of the (1) UP-1 two-way analog/digital converter using Ural-10 modules; (2) Promin' computer to process experimental data; (3) Kaktus system of computer-monitored instruction; (4) KVN-5 device for automatic vacuum spraying of thin films; (5) ChARS reader for typewritten data; (6) VNIIem-3 control computer for industrial use. A new book on the problem of optimality is of considerable interest (1) because optimality is one of the important problems now being studied by cybernetic methods, and (2) because of the publisher's foreword and disclaimer. 155 pp. (MW)

RM-6000/9-PR Soviet Cybernetics Review, Vol. 3, No. 9. Edited by W. B. Holland. September 1969.

This issue features articles and photographs of computers displayed at the Automation-69 Exhibition in Moscow, especially the Mir-1 and Ruta-110. Also discussed are the Doza analog computer for radiological dosage; "on-the-fly" output printers; other ways to increase computer speed and productivity; and the planned ultra-high-energy 1000-Bev synchrotron. Two articles give opposite approaches to the structuring of the State Network of Computer Centers, those of the Central Statistical Administration (which has the responsibility) and of Gosplan (which wants it). Programmed instruction has been sidetracked by lack of production facilities for an excellent design; L. Landa, leading Soviet authority on the subject, calls for a self-supporting educational technology institute to do research, production, installation, implementation, and to give courses open to any citizen at a nominal fee. Other articles discuss the effects of automation on the work force; mathematical training and research; computers in economics; the Latvian Academy of Science research; and the Delphi method of scientific forecasting. 139 pp. (MW)

RM-6000/10-PR Soviet Cybernetics Review, Vol. 3, No. 10. Edited by W. B. Holland. October 1969.

The October 1969 issue introduces preview synopses of new Soviet books of special interest to Western readers, and adds coverage of the new CPSU Central Committee newspaper. An overview of Soviet information retrieval work in science and technology is given in several articles and book excerpts, which decry the lack of adequate hardware, software, and personnel and the "intolerable" slowness of the publication process. System analysts, system programmers, and applied mathematicians trained in specialized higher educational institutions are particularly needed. Sciometry, a new book on the "science of science," lists the problems encountered by Soviet researchers, including lack of informal participation in international exchanges, delays in receiving foreign journals, the need for a centralized reference source and computerized information services, publication delays, and the two-way language barrier. Translated articles cover the nomination for a State Prize of the manufacturer and designer of the BESM-6; the SNCC; a logic device based on neuronlike structures; a PERT method for troop control; automatic indexing work and a new document retrieval language. 129 pp. (MW)

RM-6000/11-PR Soviet Cybernetics Review, Vol. 3, No. 11. Edited by W. B. Holland. November 1969.

Soviet efforts in designing third-generation computers are discussed in two featured articles, which describe (1) the development and production of integrated circuits, and their role in computers, and (2) the use of amorphous chalcogenide glass in lasers, infrared devices, and semiconductors. To bridge the gap between scientific theory and application, a cyberneticist suggests production-oriented branch research institutes at universities, and a university rector calls for reorganizing higher education along U.S. lines. Computer centers operate more efficiently under the profit and loss system, but pricing policies have not yet been established. Hardware discussed includes the Minsk-32, a multi-processor with multimachine capability; teletype-input CRT display for the BESM-6; the Alpha structural mechanics computer; speech recognition (41 words) by the BESM-3; remote-process control via telegraph line; and a heuristic approach to checker-playing on an M-20. 122 pp. (MW)

RM-6001-ARPA The GRAIL Language and Operations. T. O. Ellis, J. F. Heafner, W. L. Sibley. September 1969.

The important organizational concepts of the flowchart language are the sequential flow of control, the hierarchy of subroutines, and the language (flow diagrams) that pictorially relates their interdependence. A fundamental facility of the man-machine interface is the automatic recognition of appropriate symbols, which allows the man to print or draw appropriate symbols freehand. GRAIL's text-editing features include placement, replacement, and deletion of characters, character-string insertion or deletion, and line deletion. Control functions include displaying text page-by-page, requesting specified display frames, moving symbols, and test line editing. The flowchart processes may be compiled and executed at CPU speeds or the man may control interpretative execution by direct stylus actions. He may use overlay displays or split screen displays to debug. This is the second part of a final report on GRAIL. 34 pp. Ref. (See also RM-5999, RM-6002.) (MT)

RM-6002-ARPA The GRAIL System Implementation. T. O. Ellis, J. F. Heafner, W. L. Sibley. September 1969.

Interactive use of the RAND Tablet/Stylus and a CRT display demands that many independent data packages be accessed in real time without the man's being aware of system operational tasks. The internal representation of the man's program consists of its picture form, data structures to denote properties implied by the picture, and positional information to relate stylus location to the other forms. Dynamic storage allocation is automatically provided because of the large number of data sets. Algorithms are described which handle scheduling, priority, synchronization, and parallel processing. This is the third part of a final report on GRAIL. 66 pp. Refs. (See also RM-5999, RM-6001.) (MT)

RM-6018-PR An On-Line Symbolic Mathematics System Using Hand-Printed Two-Dimensional Notation. F. W. Blackwell, R. H. Anderson. December 1969.

A description of a system being developed at Rand for the on-line manipulation of symbolic mathematical expressions. The user hand-prints his formulas, and the mathematical rules to be followed, on a Rand Tablet in ordinary two-dimensional mathematical notation. The system recognizes the characters and interprets the whole expression from the spatial relationships, in accordance with a previously input syntax. The user at his console directs the computer to apply various rules of transformation that he has input. He maintains as much control over the transformations and the displays as the desires. Because the parser is entirely syntax-directed, the user can solve a wide variety of problems and can introduce novel operators as long as he declares their properties. Syntaxes that handle matrix notation and arbitrary directed-line graphs have been written and tested on the parser. 25 pp. Ref. (MW)

RM-6027-ARPA An On-Line Debugger for OS/360 Assembly Language Programs. W. H. Josephs. August 1969.

A description of DYDE, an on-line debugging program for use by assembly-language programmers on third-generation IBM computers. The ability to debug a program online can mean a significant reduction in the programmer's debugging effort. Many such on-line systems are available for other computers, notably DDT and its derivatives for the PDP computers, but none is widely known for the 360 system operating under OS, where dumps and off-line traces must be used. DYDE (Dynamic Debugger) provides the programmer with DDT-like capabilities of break-point insertion, modification of data and code, and symbolic-label references. It can operate under any option of OS/360, using only a small, user-written "ping-pong" SVC and communicating with the programmer by means of the 1052 operator's console (employing WTO and WTOR) or, preferably, the 2260 graphics console (using the OS Graphics Access Method support). 28 pp. (MW)

RM-6028-ARPA Extensions to the PL/I Language for Interactive Computer Graphics. R. H. Anderson, D. J. Farber. January 1970.

A proposed combination of the IBM Conversational Programming System (CPS) and the Rand Programmer-Oriented Graphics Operation (POGO). CPS is entirely typewriter oriented and uses a subset of PL/I with the ON-conditions and complete file I/O that are necessary in building an interactive graphical language. The facilities of POGO, which allow the user to draw on a screen the objects he wishes displayed, to label and name objects, and to define where to display appropriate items, are provided by these extensions to the language: (1) one new statement, DISPLAY, signalling the creation of a named display page; (2) additional options in the PUT and GET statements; and (3) an additional ON-condition, PUSH, that relates light-pen actions to asynchronous program responses. The requirement of command and control computer systems for flexibility, computation, graphic display, and user interaction will be served by such a connection of interactive and graphic capabilities. 24 pp. (MT)

RM-6032-PR Graphic ROCKET: Scenario of a Filmed Report. B. W. Boehm, V. R. Lamb, R. Mobley, J. E. Riebar. June 1969.

An illustration of the use of Graphic ROCKET, an interactive computer-graphics system for the analysis of aerospace vehicle designs. The system permits the user to specify or modify a design and flight plan and to see the resulting performance curves displayed. Graphic ROCKET runs on an IBM 360/40 computer. The interactive graphics terminal includes an IBM 2250 cathode-ray-tube display with a light pen, keyboard, and function keys. Hardcopy is provided by and S-C 4060 graphic output device. The program language consists of a series of "pages," created and interfaced via the POGO System (RM-5825), and displayed on the cathode-ray tube, for specifying initial conditions, environmental models, and flight plans. Control boxes on each page permit the user to skip from page to page with the light pen as he defines the problem he wants to solve. Graphic ROCKET is shown in terms of a real-life problem of designing an air-launched satellite booster for photographing hurricanes. This memorandum is the text of a demonstration film presented at the Design Automation Conference in June 1969. 54 pp. Ref. (MW)

RM-6047-RC Biosciences at Rand. Edited by E. C. DeLand, C. Gazley, Jr., L. L. Colbert. April 1970.

Describes Rand's current programs and potential new projects in the biosciences --biochemistry, biomathematics, and bioengineering--which apply the physical, mathematical, engineering, and computer sciences to biological and medical problems. These applications can clarify complex physiological mechanisms and develop better diagnostic and clinical procedures. Current studies may be grouped in 3 general categories: (1) physiological models and computational techniques to analyze and quantify the biochemistry of human physiological systems and phenomena; (2) analyses of the mechanics and neurophysiology of human vision, pattern recognition, and image enhancement to facilitate information transmittal; and (3) clinical applications and diagnostic techniques. Potential future projects include additional fundamental research in all the biosciences, investigations of complex biological and health care systems, and development of computer support for bioscience programs. This memorandum does not address studies centered in experimental laboratories or those primarily concerned with the economics, sociology, or administration of health care systems. 77 pp. Bibliog. (LC)

RM-6104-ARPA User's Manual for APAREL: A Parse-Request Language. R. M. Balzer. January 1970.
A description of the present implementation of APAREL as a set of subroutines callable from PL/I. The memorandum mentions features not yet implemented, use restrictions, new additions, and methods for use of the program. Added features include a NOT function and the ability to redefine parse requests dynamically, to trace a parse request dynamically, and to force the system to parse every character in the input string. An on-line syntax checking program for use with the IBM 2260 alphanumeric display unit is appended to aid the user in specifying and testing his syntax in APAREL format. The on-line interaction is supplied by a set of PL/I callable routines written at Bell Laboratories. A BNF definition of APAREL's syntax language is also included. APAREL was developed not only to explore newer areas of man-machine communication but also to assume responsibility for establishing its value to the military via prototype systems. 46 pp. Ref. (see also RM-5611-1.) (MW)

RM-6112-PR Computer Graphics for Simulation Problem-Solving. T. E. Bell. December 1969.
A description of the use of interactive computer-graphic analysis in simulating, and then designing and developing, Rand's Video Graphics System, which will provide low-cost, high-capability, responsive, graphic computer access to many users simultaneously. Simulation began before the system was fully defined, as an aid to design. The graphic displays were presented on an IBM 360/40; the user entered data via the RAND Tablet. Of the three types of display--Statistics, Variable Graph, and Gantt Chart--the latter was used most. Graphic analysis cut total modeling time approximately in half. Since much hard copy was pasted into strip charts, these should be produced automatically. Graphics capabilities facilitated analysis of a large volume of simulation output to examine the model in detail and to discover anomalous behavior; ongoing simulation proved a valuable aid to design. 28 pp. Bibliog. (MW)

RM-6114-PR POGO User's Manual: I. General Aids to Graphic Programming. J. E. Rieber, V. R. Lamb. January 1970.
Detailed operating instructions for the control page design and interactive graphic facilities of the Programmer-Oriented Graphics Operation. POGO supplements the facilities of IGS for the IBM 2250 graphics console by freeing the user of many tedious chores and repetitious coding. With POGO, the user creates his displays freehand at the RAND Tablet. Information may be handprinted, drawn, or typed in. After the display has been designed, POGO files the digital information. The user can then write a simple FORTRAN program containing calls to the POGO execution-time routines, which will interact with his displays. Appendices give program source listing, the Job Control Language for running POGO jobs on the IBM 360, and the 2250 buffer management routines. POGO has been used in the geographical deployment of men and artillery for a computer model of tactical air-ground interactions, aerospace vehicle trajectory analysis, and map data digitization. 192 pp. Ref. (See also RM-5531, RM-5825.) (MW)

RM-6132-NASA ECSS: An Extendable Computer System Simulator. N. R. Nielsen. February 1970.
Describes the major design features of ECSS, a programming language for simulating computer systems as an aid to design and evaluation. In its prototype version, ECSS is implemented as a translator into SIMSCRIPT II with extensions to add further capabilities. ECSS can model flow-oriented as well as discrete-event simulations, having added to SIMSCRIPT the SIMULA-like process, which is both an entity and an event subroutine, and the HOLD UNTIL and WHEN TRUE statements. The emphasis throughout is on ease of use, freedom in modeling, and on minimizing programming and debugging time. Standard features can be simulated merely by requesting the facilities and inputting data; for nonstandard features, the user writes his own description in SIMSCRIPT and uses as much as he wishes of the ECSS facilities. Unused facilities do not affect execution. Implementation of the ECSS translator is now under way. 53 pp. Ref. (MW)

RM-6200/1-PR Soviet Cybernetics Review, Vol. 4, No. 1. Edited by W. B. Holland. January 1970.

The January issue features a major historical survey of Soviet computer technology, including photographs of nearly all Soviet computers in operation today. The article covers Soviet computer development, beginning with an analog device in 1941 and continuing through current efforts to incorporate integrated circuit technology, including the Ryad project which is aimed at eventual production of System/360-compatible hardware. The Mir-2 computer with graphic terminal light pen is discussed. Overheating in vacuum tube computers, a nagging problem for the Soviets, is explored. Other articles probe computerized crime detection, automated machine system development, computerized national economic planning, automation in the State Bank, and use of computers in planning Western Basin fishing fleet operations. 87 pp. (TC)

RM-6200/2-PR Soviet Cybernetics Review, Vol. 4, No. 2. Edited by W. B. Holland. February 1970.

Discussion of an ambitious Soviet project to totally automate airport operations highlights this issue. Automated control systems for flight scheduling, passenger services, aircraft maintenance, and other operations will be introduced in the country's 20 largest airports by 1975, the Russians claim, beginning with Moscow's Vnukovo Airport. An SCR feature surveys Soviet use of computers in medicine, noting achievements in computer diagnosis of cardiac diseases, computer use in brain and cancer research, and in treatment of paralytics in Soviet health resorts. Other articles consider the proposed role of the Central Statistical Administration in implementing the State Network of Computer Centers; the organization of national control systems; use of the computer in musical composition; and Soviet work in linear programming. 46 pp. (TC)

RM-6200/3-PR Soviet Cybernetics Review, Vol. 4, No. 3. Edited by W. B. Holland. March 1970.

Four articles devoted to process control and industrial automation are featured. One summarizes progress in the introduction of automated control systems in 5 Leningrad plants. Leningrad is second only to Moscow in Soviet R&D. Another details the use of computerized systems by the Soviet railroad network, including system shortcomings. Of interest are plans for an automated ticketing and seat reservation system the Soviets say will streamline passenger handling, trim employee workloads, and completely pay for itself in 4 years. It is scheduled for introduction by 1975. Other articles examine trends in the development of process control systems, computer selection of specialization curricula in computational mathematics, and use of the computer to simulate experiments in psychology. A recent Pravda item reveals that basic design of the M-1000 was conducted under the auspices of the Tbilisi Scientific Research Institute of Instrument Construction and Means of Automation, a group not previously identified with any significant Soviet computer developments. 53 pp. (TC)

RM-6200/4-PR Soviet Cybernetics Review, Vol. 4, No. 4. Edited by W. B. Holland. April 1970.

Featured are 3 articles by top Soviet computer scientists: V. M. Glushkov discusses trends in computer technology in 2 articles, specifically computer center organization. Leading computer designer S. A. Lebedev writes about the conversion to third-generation design techniques and large-scale integration. An article surveying solid-state technology covers such subjects as integrated circuits, elionics (electron- and ion-beam techniques), optoelectronics, dielectronics, and acoustoelectronics. An article on the the ASP automated design system, which uses the M-220 computer, examines ASP's basic design stages and designer/computer interaction during mathematical modeling and machine design. Other articles consider: (1) the new Dnepr-2 control system, (2) a hybrid analog-digital system for use in physics and chemistry research, and (3) the use of activated alkali halide crystals as luminescent storage cells. A Pravda editorial on the burgeoning "information industry" is also included. 52 pp. (TC)

RM-6200/5-PR Soviet Cybernetics Review, Vol. 4, No. 5. Edited by W. B. Holland, May 1970.

This issue features an identification of the new Kashatan computer, and also the Avtopriz-Autevo system, which was jointly developed by the Russians and East Germans to solve industrial production control problems. A highlight of the issue's treatment of software problems is the translated abstracts of papers from 8 sessions of the Second All-Union Conference on Programming, held in February. One article continues a discussion begun in April's SCR over whether implementation of national control systems should begin on a state-wide basis or at the local level. A discussion of software development advocates concentrating computers in large centers to increase efficient computer use. Other articles (1) probe close ties between the VUM Plant (Kiev Plant of Computers and Control Equipment) and the Institute of Cybernetics, (2) outline 4 optimal schemes for complex control systems, (3) examine faltering automation plans in the textile industry, (4) announce establishment of a control processes faculty at Leningrad University, and (5) discuss space and naval research at the Institute of Cybernetics. 59 pp. (TC)

RM-6200/6-PR Soviet Cybernetics Review, Vol. 4, No. 6. Edited by W. B. Holland. June 1970.
Featured in this issue is a report by a top Soviet computer expert to the First All-Union Conference on Programming. Topics covered are: the 5-year programming gap, hardware design shortcomings, and repetitive research. A photo-feature tracing the history of teaching machine use identifies prominent figures in the field and describes an array of hardware, from simple machines to complex computer-controlled classrooms. Two articles review problems of the computer industry, demanding stringent collective use systems. Other articles include: (1) organizational detail of the Central Economic Mathematics Institute; (2) a survey of computer use in Armenia and Belorussia; (3) two pieces on the BESM-6 computer, one that details its use in linear acceleration experiments; (4) an overview of neurobionics; (5) a discussion of training programming teachers; and (6) an examination of cybernetics in the scientific revolution. 61 pp. (TC)

RM-6200/7-PR Soviet Cybernetics Review, Vol. 4, No. 7. Edited by W. B. Holland. July 1970.
The Ukraine figures prominently in three articles in this issue. The first is based on the 1969 Annual Meeting of the Ukrainian SSR Academy, at which the subject of economic cybernetics was discussed. The work of the Academy's various economic institutes is outlined, summarizing some of the highlights of research in mathematical economics and control systems. The second article on the Ukraine discusses achievements and problems of computer systems in the Republic, particularly industrial applications for process control. The final article is a popularized description of the automatic computer design system developed at the Kiev Institute of Cybernetics. Also featured are photographs and description of the Ruta-110D, the first Soviet disc memory unit on display in Moscow at the Exhibition of National Economic Achievements. Other articles on computer activity analyze the dispute that is currently raging in Polish technical circles and on the system of computer centers in Romania. With this issue, Soviet Cybernetics Review initiates a bimonthly publication policy. 48 pp. (KB)

RM-6200/8-PR Soviet Cybernetics Review, Vol. 4, No. 8. Edited by W. B. Holland. September 1970.
Soviet R&D is redirected toward industrial needs. Besides computers and automation, major attention is on power engineering, electronics, nuclear applications, chemistry, earth sciences, economic control, and microbiology. Microorganisms are the reagents in the first large-scale production of protein from petroleum hydrocarbons. Automatic diagnosis of brain tumors was 85 percent successful by computer, 90 percent by diagnostic table. Computers are little used for accounting. Ukrainia's scientific/technical information system includes a fund of over 2500 algorithms, programs, and user's guides. Romanian electronic progress is reported. The usual complaints of inefficiency, waste, and delay of automation appear, as do the usual reports of savings. Tbilisi emerges as a major computer design center with the Tbilisi-1 process controller and M-1000, first of the third-generation modular Soviet computers. The BESM-3M read/write head wears out tapes. Other hardware is discussed or pictured. 77 pp. (MW)

RM-6213-PR Some Information Processing Implications of Air Force Space Missions: 1970-1980. B. W. Boehm. January 1970.
Text of a briefing to the Air Force Scientific Advisory Board on problems in space and flight computing. Off-the-shelf information processing is inadequate for real-time image processing, multisensor analysis, decision-oriented displays, and the Space Transportation System. Undetected program errors could lead to dangerous strategic confrontations or incapacitate a key defense at a critical time. The Air Force should (1) push development of a high-capability, high-capacity, floating-point on-board computer; (2) buy at least 50 to 100 percent more computing capacity than is absolutely necessary, to avoid complex space-saving programming; (3) begin serious work on the STS software now; and (4) study the feasibility of an Air Force software testing facility comparable with hardware testing facilities. 53 pp. Ref. (MW)

RM-6248-PR JOSTRAN: An Interactive JOSS Dialect for Writing and Debugging FORTRAN Programs. W. R. Graham, D. C. MacNeilage. February 1970.

A description of JOSTRAN, a JOSS dialect that expedites the construction of FORTRAN programs. JOSS is an interactive, on-line computer system developed at Rand under Air Force funding, and now used extensively throughout Rand, the DOD, and industry. JOSS-language programs are list-processed; i.e., each statement is interpreted at execution time. FORTRAN is the principal language for programming digital computers to perform numerical calculations. Because most FORTRAN programs are batch-processed, the programmer cannot immediately examine the output. The JOSS language permits greater flexibility and subtlety, but FORTRAN can handle larger calculations. JOSTRAN, a specified FORTRAN-compatible dialect of JOSS, combines the advantages of both languages. It allows the user to exploit JOSS's interactive, list-processing facilities while writing and debugging a program, and facilitates the translation of the JOSTRAN program into FORTRAN. The translation is verified by test calculations in both languages. 15 pp. (LC)

RM-6256-PR Tracking Error Propagation and Orbit Prediction Program. R. Mobley, L. N. Rowell, M. C. Smith. July 1970.

Description of TEPOP (Tracking Error Propagation and Orbit Prediction Program), a Rand-modified FORTRAN IV program used in the AFSC/ADC Joint Mission Analysis on Surveillance of Objects in Space. TEPOP simulates space-vehicle tracking data from as many as 54 sensors. Rand improvements: Sensors may be satellite-based, may rotate, may be limited in azimuth, elevation, and range; drag bias can be included; the JPL ephemeris tape is used; the program was converted to double-precision. Besides determining a target's path from real data, TEPOP can be used to generate synthetic data for objects orbiting earth, sun, moon, Mars, Venus, or Jupiter, or on an interplanetary course; to study the effects of introducing random and systematic errors; and to generate confidence regions for position and velocity. The reference coordinate system is automatically centered on whichever body influences the tracked object at the time. 74 pp. Ref. (MW)

RM-6271-PR A Preliminary Inquiry into the Software Estimation Process. J. A. Farquhar. August 1970.

Reviews the literature of software estimation and reports a small experiment comparing Delphi with face-to-face group judgment to predict the time necessary to program an information system--in this case, the Air Force's PDSO (Personnel Data System --Officers). Planning software production is necessary but almost impossible at present. Cost to completion depends on many factors, some unknown at the time and all hard to quantify (the difficulty of the task, the programmer's ability and familiarity with the procedures involved, the degree of definition provided him, and about 80 other factors). The experiments undertaken failed to establish the utility of either estimation method. Primary recommendations for further research are: (1) more effective data collection, (2) analysis of characteristics of good estimators, and (3) formal inquiry into the techniques used by estimators. 56 pp. Ref. (MW)

RM-6297-PR Statistical Concepts in Computational Mathematics. M. L. Juncosa. November 1970.

Discussion of the strong dependence of computer science on probability and statistics. This Rand study in computational mathematics and its applications offers a number of examples to illustrate this dependence and is a potentially profitable source of research problems in the interface between probability and statistics and computer science. Some examples deal with numerical processing of algebraic quantities, stabilizing solutions of equations, and computer arithmetic processes. As a consequence of the dependence noted, it is recommended that computer science education planners include a prerequisite of probability and statistics. In addition, numerical analysts and other computer users involved in numerical data processing will find the examples and the list of references useful in seeking methods to control rapid numerical error growth in their computations. 36 pp. Ref. (KB)

RM-6313-PR Use of Magnetic Tape for Reporting Cost Information. J. String, Jr. September 1970.

As an alternative to the current practice of submitting cost reports on paper, this study suggests incorporating the capabilities of electronic data processing in the design of reporting systems and using magnetic tape as the primary medium for reporting and storing data. Instead of submitting printed reports, a contractor would provide documentation of his accounting system and work assignment structure at the initiation of a procurement program, and provide periodic tape copies of his internal accounting records during the acquisition phase. A sample program was selected as a test case and all major tasks were performed, including in-depth reviews of the contractor's accounting system and the procurement program's work breakdown structure. A series of specialized paper reports were printed using a generalized report-generating program written for the project. No problems were encountered that could be attributed to the basic concepts of the system or to the principal elements of implementation. 55 pp. (DGS)

RM-6338-ARPA A Dynamic Programming Approach to Network Problems: A Model for On-Line Computer Systems. L. J. Pipes. August 1970.
Derivation, documentation, and listing of a dynamic programming model on JOSS for finding optimal solutions (minimum-cost paths) to network problems. The network represents the possible connections between decisions and expresses costs of going from one to another. The model encompasses a value-iterative algorithm which successively converges to the solution. The principle of optimality, which permits finding the minimum-cost (shortest) path as a function of the maximum number of arcs allowed, is: Regardless of how a particular state was arrived at, the remaining decisions as to what path to take enroute to the terminal must themselves constitute an optimal solution. The costs of traversing arcs may be input, recalled from other files, or calculated by JOSS from input functions. Model flexibility allows for testing the sensitivity of a decision process to changes in the terminal point. 28 pp. Ref. (MW)

PAPERS

P-2584 Operating Systems. G. H. Mealy. May 1962.
A discussion of operating systems, defined as the whole complex of programming, debugging, and operational aids with which the programmer deals. The components of an operating system are divided into input-output systems, processors, and supervisory systems. Input-output systems are codes used in conjunction with the hardware to get data in and out of the machine. Processors are codes that transform data. Supervisory systems are codes that are responsible for job or task sequencing and for communication between the programmer and the components of the operating system. The provision of a coherent set of communication conventions is emphasized to promote flexibility of construction and use. 95 pp.

P-2586 Benchmarks in Artificial Intelligence. F. J. Gruenberger. June 1962.
A list of tasks, presently performable by most human beings, that may eventually be handled successfully by computers. These tasks may serve as milestones in the field of artificial intelligence. 13 pp.

P-2593 The Use of Computers in the Processing and Analysis of Geographic Information. R. C. Kao. December 1963.
An assessment of the impact of high-speed computers on the collection and use of data in geographic research. The following are discussed: (1) the way in which the impact is felt, (2) geographic problems likely to arise with the increasingly widespread use of high-speed computers, (3) adoption of a universal mapping system, and (4) problems facing users of geographic data. 28 pp.

P-2597 Computer Training and Education: The Picture in 1962. F. J. Gruenberger. July 1962.
A discussion of the problem of education and training in the world of computers. The author describes: (1) the difference between this educational and training problem and the problem for masses of people in any other skill or technology and (2) the difficulties in training and/or educating masses of people in computer technology. It is suggested that the educational discount on computers be abandoned in the near future. 11 pp.

P-2602 99-GATE. T. A. Van Wormer. August 1962.
A primer for instruction in the 99-GATE language. 99-GATE is a system in which a computer may be instructed to perform algebraic computations. Specifically, 99-GATE is: General Algebraic Translator extended for the IBM 709/7090. The author indicates the rules to be followed and the techniques to be used in instructing the computer. 48 pp.

P-2608-1 What is DETAB-X? S. L. Pollack. October 1962.
A description of a computer language based on the use of decision tables, DETAB-X (Decision Tables, Experimental). The

paper traces the evolution of computer programming and the steps in its development. The desirable features for a problem-analysis technique are discussed together with a comparison of DETAB-X and COBOL-61. DETAB-X was developed at Rand as part of a continuing effort to devise methods that will permit the Air Force and other large users of computers to reduce costs and time-lags involved in designing and implementing data systems. 26 pp.

P-2610 How Cities Should Approach Data Processing. R. J. Mason. July 1962.
A discussion of the impact on government operations of advances in data-processing equipment. Future equipment will improve all five of the data-processing activities and will be available in the size, capability, and price to meet any city's needs. The ideal system for cities is one in which environmental data gathered by all departments are filed in unified, central records describing persons or parcels of real property. These central files will replace many existing files, since they will be available to all departments for use in their normal operations. Eventually, these central files will cover more than one city. Proper use of data-processing equipment will lead to better decisions based on more inclusive data, and ultimately to significant operating economies and improved city operations. 9 pp.

P-2658 A Quick Look at SIMSCRIPT. H. W. Karr. October 1962.
A description of SIMSCRIPT, a general programming system specially adapted to the problems of writing simulation programs. The advantages of SIMSCRIPT are that it reduces the time needed to program simulations of even moderate complexity and provides increased flexibility in modifying such models in accordance with the findings of preliminary analysis and other circumstances. Although SIMSCRIPT may be used as a computer language for nonsimulation problems, the author emphasizes its application to simulation. Detailed instructions and forms for applying SIMSCRIPT are also provided. 14 pp.

P-2674 Anatomy of an Assembly System. G. H. Mealy. December 1962.
A description of the GAS (Generalized Assembly System) language and of the organization of the GAS processor. One of the features of GAS is that routines may be defined and added to the assembly system at assembly time. This allows the possibility of changing the syntax or semantics of the source language during assembly. Therefore, the programmer who wishes to change GAS must know how it is constructed. The possibility of this, in any practical sense, is dependent on the organization of the assembly system and on its documentation. The author attempts to provide enough information about GAS to allow modification of this language at assembly time. 30 pp.

P-2687 Status Report of DETAB-X (Decision Tables, Experimental). S. L. Pollack. January 1963.
A status report on DETAB-X (Decision Tables, Experimental). This potential business language was introduced at a Decision-Table Symposium in New York, 20 September 1962. Decision tables in general are set up in a tabular format containing a set of decision rules based on a given set of conditions. Each decision rule describes the sets of conditions that must be satisfied for a given sequence of actions to be taken. The CODASYL Systems Group developed specifications for DETAB-X, a decision-table structure using modified COBOL-61 for business-problem description. As DETAB-X has proven to be a significant development in data processing and a valuable addition to COBOL, the CODASYL Systems Group will probably propose that DETAB-X be adopted as an addition to COBOL. 7 pp.

P-2697 DETAB-X and the World of Banking. S. L. Pollack. February 1963.
A description of DETAB-X (Decision Tables, Experimental), an experimental language that combines COBOL-61 and decision tables. The use of DETAB-X in business-oriented problem description is discussed with particular reference to banking systems. It is felt that programs written in DETAB-X will provide improved communication between system designers, programmers, and functional specialists. DETAB-X is also expected to increase the accuracy and completeness of problem statement achievable by existing languages. 12 pp.

P-2714 Electronic Data Processing for Cities--The Broad Look. E. F. R. Hearle. February 1963.
A summary of what electronic data-processing equipment can do for cities now and in the near future. Modern automatic data-processing equipment greatly increases the capability of municipal agencies to handle information, especially if an over-all, integrated system serving the entire muni-

cipal organization is developed, rather than a piecemeal mechanization of familiar clerical operations. 11 pp.

P-2768 The Why and How of Computing in the Secondary Schools. F. J. Gruenberger. September 1963.
An argument in favor of including computing in the high school curriculum. Considered are the reasons for teaching it in high school, the problems of acquiring a computer for high school use, the proper place of computing in the curriculum, and the main types of problems that high schools could use a computer to solve. 9 pp. (See also P-2786.)

P-2782 Programmer Selection Report for SHARE XXI. R. N. Reinstedt. August 1963.
A discussion of personnel problems in hiring programmers for computers. 14 pp.

P-2786 What Should We Compute? F. J. Gruenberger. September 1963.
A discussion of the efficient use of a computer. Seven criteria are given as a guide in determining whether the use of a computer is justified for a particular problem or whether some other method of calculation would be preferable. 14 pp. (See also P-2768.)

P-2791-1 Computers and Information Flow. R. L. Patrick. March 1968.
An introduction to computers for the decisionmaker who needs a layman's knowledge of the field (updated from a UC Extension lecture). Hardware, software, rental arrangements, and programmer relations are described. Useful classifications of types of computing include the misnomers "scientific" (meaning little input-output and much arithemetic) and "business" (meaning very high input-output and very simple computations, as in payrolls). Also defined are batch, on-line, and real-time processing. Process control and military command and control are discussed as on-line applications. the indications of a latent computer need usually are: (1) a volume operation of which the the repetitive portions can be defined and the exceptions recognized; (2) any extremely complex job; (3) a need for immediate results; (4) a large file that must be current and accessible to several users; (5) extremely precious data that require sterile handling. 19 pp.

P-2793 The Programmer in a Changing World. W. H. Ware. September 1963.
An inquiry into the role of the professional programmer in the future computing world. The programmer may continue to be needed for unusual machine problems and in computer research, but it may be that the ability to present a machine to its user on his terms will improve so rapidly that programming as a specialty will become a relatively small professional field or a secondary skill shared by people from a wide variety of professional disciplines. 5 pp.

P-2826 Simulating with SIMSCRIPT. H. M. Markowitz. November 1963.
An examination of two aspects of SIMSCRIPT which enable it to reduce the programming time required for simulation. These are its world-view of the model to be simulated and its method of communicating to the computer the world to be simulated. 15 pp.

P-2863 Bigger and Better Mathematicians. R. E. Bellman. February 1964.
Mathematicians urgently need much larger and faster computers for solving a large category of practical problems. Work should have begun five years ago on digital computers 100 to 1000 times faster and 1000 to 1,000,000 times larger than current computers. Attention, however, seems to have been diverted by "gimmickery" and the glamour of "thinking machines." The author sees little hope of improvement. 6 pp.

P-2864 GASP--A General Activity Simulation Program. P. J. Kiviat, A. Colker. February 1964.
An introduction to the capabilities of GASP (General Activity Simulation Program). GASP can be understood by engineers as well as by computer programmers. It provides uniformity in system description and includes as many automatic error detection and debugging systems as possible. GASP cannot compete with SIMSCRIPT but serves well those who have only a small machine or who use several computers with no common language. 9 pp.

P-2865 On the Explosion of Automation. R. E. Bellman. February 1964.
Comments on the impact of automation on a capitalistic and democratic society. While automation would increase even without computers, its effects are intens-

ified by them. Coupled with an increase in general efficiency and in advanced technology, automation will remove many jobs from industry. The author points out the need for training and retraining of the resulting unemployed. 5 pp.

P-2879 On Cybernetics, Information Processing, and Thinking. M. E. Maron. March 1964.

An examination of the origins, development, and present status of those key cybernetic notions that provide an information-flow framework within which to attack one aspect of the question of how a person thinks; i.e., the question of the information mechanisms and processes which underlie and are correlated with thinking. Defined and analyzed are (1) the origins and scope of cybernetics, (2) information processing in artificial and natural systems, (3) the problem of artificial intelligence, and (4) cybernetics, neurophysiology, and epistemology. 41 pp. Bibliog.

P-2908 Science, Technology and the Automation Explosion. R. E. Bellman. May 1964.

A consideration of the serious effects of our economic and political structure arising from the rapid spread of automation. As it takes over more and more routine occupations, people will be required to engage more in personal and certain professional services. The author feels that some attempt must be made to face the problem now instead of wishfully letting the matter take care of itself. 6 pp.

P-2922 JOSS: A Designer's View of An Experimental On-Line Computing System. J. C. Shaw. August 1964.

A description of JOSS (JOHNNIAC Open-Shop System), an experimental on-line, time-shared computing service. The paper emphasises those features which have made JOSS a convenient new tool. 33 pp.

P-2967 Programming Language Selection for Command and Control Applications. J. P. Haverty. September 1964.

A discussion of major considerations in selecting a programming language for command and control applications: (1) systems considerations; (2) language and compiler requirements. The paper illustrates the difficulties of programming language selection by citing recent American work in measuring effectiveness. The problems of standardization are also mentioned. 25 pp.

P-2998 The Teaching of Computing. F. J. Gruenberger. October 1964.

A discussion of the characteristics of the teaching of computing and the ways in which it significantly differs from the teaching of other subjects. 5 pp.

P-3006 The Logic of Interrogating a Digital Computer. M. E. Maron. November 1964.

An attempt to clarify the problem of how a computing machine must be organized to deal with language in order to respond to interrogation as if it understood meanings and relevance. The paper is divided into three parts: (1) an outline of the origins and scope of the information sciences and the impetus they have given to this search; (2) a look at two sub-problems, literature searching and data retrieval, to suggest how these problems should be framed; and (3) a consideration of the question of comprehension with the aim of specifying how some aspects of knowing can be discussed in a mechanical way and related to the information organization required to generate comprehension-like behavior. 23 pp. Bibliog.

P-3044 The Role of the Computer in Secondary Schools. F. J. Gruenberger. January 1965.

In the five years since stored program computers have been used in secondary schools, a pattern of solid academic courses has emerged. The paper lists eight reasons to justify continuance of the program. 4 pp.

P-3086 Use of Hybrid Computing in Design Automation. A. J. Rowe, P. Brock. March 1965.

A discussion of computer-aided design for engineering use. The automatic drafting project of the Hughes Aircraft Company is described, including the development of ADMA, the machine and the language. The concept of the engineering information center is discussed. 22 pp.

P-3109 A Charting Technique for the Analysis of Business Systems. E. A. Nelson. May 1965.

Description of a charting technique for analyzing business systems and studying the information economics of firms. This technique facilitates establishment of criteria for system effectiveness by portraying details and interrelationships of functional tasks, management decisions, organization structure, information flows, and data processing. 17 pp.

P-3131 JOSS: Examples of the Use of An Experimental On-Line Computing Service. J. C. Shaw. April 1965.
A presentation of examples of the use of JOSS (Johnniac Open Shop System) for the solution of small numerical problems. 10 pp.

P-3141 Simulation Programming and Analysis of Results. A. S. Ginsberg. May 1965.
A discussion of techniques for simplifying and speeding simulations and for increasing the meaningfulness of results. General Purpose Systems Simulator II (GPSS), SIMSCRIPT, and programming by questionnaire are discussed as examples of simulation programming. 9 pp.

P-3144-1 Cybernetics. M. E. Maron. December 1965.
A review of the concepts of cybernetics. Communication theory and the digital computer are discussed as forces that shape the development of cybernetics. Current interpretations of the meaning of cybernetics are also discussed. 9 pp. Bibliog.

P-3146 JOSS: Conversations with the Johnniac Open-Shop System. J. C. Shaw. May 1965.
A brief description of JOSS and examples of conversations in which the system is directed in a high-level algebraic language. 5 pp.

P-3149 JOSS: Experience with An Experimental Computing Service for Users at Remote Typewriter Consoles. J. C. Shaw. May 1965.
A report of the history and benefits of JOSS (Johnniac Open-Shop System), a computing service which monitors ten typewriters and serves up to eight users concurrently. It has been in daily use at RAND since January 1964. The author discusses both the hardware and software, and the training necessary to operate the system. 18 pp. Bibliog.

P-3163 What Is the "Social Responsibility" Problem? F. J. Gruenberger. July 1965.
An inquiry into the effects of automation on employment and the problems confronting social and computer scientists in assessing the magnitude of these effects. 8 pp.

P-3168/1 NOSY: A Core-saving Operating System. I. L. Finkle, L. Scantlin. July 1967.
A revision of P-3168 to reflect the change in RAND's computer system from an IBM 7040 coupled to a 7044, to the 7044 alone. This Paper describes the NOSY (NonSYS) software for use with programs that exceed available storage on the 7044. Converting codes from FORTRAN II to FORTRAN IV causes loss of core storage because the IV compiler in most cases produces more instruction words than the II compiler, and because the IBSYS nucleus requires so much storage space. The NOSY method eliminates the nucleus during execution, thus releasing core storage at the cost of less efficient input/output. It was devised originally for a RAND two-dimensional hydrodynamic model that continued to exceed available storage even when a chaining procedure was used. 12 pp.

P-3235 Communications, Computers and People. P. Baran. November 1965.
Discussion of the impact of computer technology on communications and the effect of low cost digital communictions on computer systems. The paper presents the social consequences of the reciprocal action and suggests remedies for the problems that may rise. 20 pp.

P-3236 Is the Data Processing Field So Different? F. J. Gruenberger. September 1965.
A consideration of the need for companies who plan to install electronic data processing equipment to seek the guidance of EDP experts. Cost analogies for similar professional services are given. 4 pp.

P-3279 Future Computer Technology and Its Impact. W. H. Ware. March 1966.
Text of a paper presented to the Board of Trustees and the Air Force Advisory Group in November 1965. The author discusses the digital computer as an information processing machine, describes the advances made in computer hardware in the 15 years of its commercial lifetime, suggests future computer achievements, and considers

the impact on society, business, industry, and the military. 29 pp.

P-3281 Are Small, Free-Standing Computers Here to Stay? F. J. Gruenberger. December 1965.
An assessment of computing-power per dollar in small machines. It is increasing rapidly and will continue to do so. At present, distinct advantages are to be found in the free-standing machine over a large, time-sharing facility, depending on the particular project. The Paper speculates that, in time, developments will allow a free-standing machine to be hooked up to a large central facility for short bursts, and thus secure the best of both systems for users. 8 pp.

P-3313 JOHNNIAC Eulogy. W. H. Ware. March 1966.
Text of a talk at the decommissioning ceremonies for the RAND-built computer, JOHNNIAC, held 18 February 1966. The history and development of JOHNNIAC are traced from the early search for more computing power in 1950 to the very recent use of the computer as a research tool. The press release of JOHNNIAC's demise is appended. 14 pp.

P-3314 Introduction to the SIMSCRIPT II Programming Language. P. J. Kiviat. February 1966.
Presentation of the design philosophy behind SIMSCRIPT II. The paper notes the incorporation of accumulated experience into the programming language, describes the implementation and structure considerations, and reveals some of the language's important features and innovations. 7 pp.

P-3348 Development of New Digital Simulation Languages. P. J. Kiviat. April 1966.
An article prepared for The Journal of Industrial Engineering. It includes: (1) an examination of theories of simulation and modelling and programming; (2) a description of the design aims and a few language statements of SIMSCRIPT II, a second generation simulation programming language; and (3) comments on a probable future for simulation languages and simulation programming. 21 pp. Bibliog.

P-3349 Simulation Language Report Generators (or, I Hear You but I Don't Know What You're Saying). P. J. Kiviat. April 1966.
Paper prepared for the Symposium on Simulation Techniques and Languages, London, May 1966. The author discusses simulation programming languages and their particular need for specialized output statements. The structure of future simulation language report generators is predicted through descriptions of the programmers' and managers' need for reports about or from simulation models and programs. A set of programming statements that satisfy these needs is presented and related to the simulation programming languages of today and the future. The programming statements are in SIMSCRIPT II, but the use is illustrative only; they have not been implemented. Examples of the reports generated by the hypothetical statements are included in the Appendix. 25 pp. Bibliog.

P-3365-4 Bibliography on Automation and Technological Change and Studies of the Future. A. Harrison. March 1971.
Last published in 1967, this current bibliography lists works associated with two ongoing Rand projects: Automation and Technological Change, and a related informal study of future national and international problems. Alphabetically arranged, the bibliography contains approximately 800 entries, consisting of the assembled works of project members, together with some 400 additional entries published after 1967, selected largely from the Library of Congress card catalog. The appendix lists private organizations engaged in, or planning to engage in, future-oriented work. The bibliography will continue to be updated periodically. 58 pp. (SM)

P-3408 Relational Data File I: Design Philosophy. M. E. Maron. July 1966.
The design philosophy and general objectives of the Relational Data File, an automatic question-answering system. The File permits factual data to be stored in a digital computer so that the machine can respond appropriately, giving answers to questions based on the stored information. (One of two related papers presented at the Third Annual National Colloquium on Information Retrieval, 1966.) 26 pp. Ref. (See also P-3411.)

P-3411 Relational Data File II: Implementation. R. E. Levien. July 1966.
The techniques used for implementation of

the Relational Data File, a computer-based system for the storage, retrieval, and logical analysis of factual data. (One of two related papers presented at the Third Annual National Colloquium on Information Retrieval, 1966.) 26 pp. Ref. (See also P-3408.)

P-3453 Development of Discrete Digital Simulation Languages. P. J. Kiviat. September 1966.
A discussion of the history, current status, and possible future of computer languages that are used for describing the structure and dynamics of discrete-time systems. The author discusses principal features of the numerous simulation programming languages in current use and predicts eventual merger into one or two general-purpose languages that can be used to construct special-purpose simulation languages. 16 pp. Ref.

P-3466 The Coming Computer Utility --Laissez-Faire, Licensing or Regulation? P. Baran. April 1967.
The growth of the computer industry, which presses upon existing regulatory processes, makes necessary a re-examination of the entire regulatory structure for data transmission. At present, communications suppliers are highly regulated, while computer companies are not. The cost for computation is dropping so rapidly that the cost of the communication needed to tie together many users of a single machine is now the overriding cost limitation. Concentrating the traffic from a large number of users in order to share expensive transmission circuits is illegal unless a single company is involved (giving a disproportionate advantage to large companies). The most basic regulation mechanisms needed by future computer utilities are: professional licensing standards to aid in safeguarding privacy of information; removing the economic advantage to large companies; and providing free exchange across systems. 27 pp.

P-3476 The Catalog: A Flexible Structure for Data Storage. T. W. Ziehe. November 1966.
An overall view of the Rand text and catalog system described in RM-4390 for processing natural language text for computer storage in large files. The system provides freedom to reorganize the files at will. Organization is based on the dependency tree. Data within any one class may be encoded in any form, disregarding the rest of the file, and the nature of the coding is indicated on the catalog map (index). Catalogs can be nested, and each catalog may be structured separately. A valuable space-saving device is the null datum, in which headings without any data fulfill their organizing role without occupying any physical space. Computer programs convert text into its internal representation. Formats have been defined for 7-bit magnetic tape and 36-bit-word core storage, and others will be added. Catalog transformation schemes are also planned for the future. (Presented at the Conference on Computers in Humanistic Research, Texas A. & M., November 1966.) 22 pp.

P-3478 Computer Aspects of Technological Change, Automation, and Economic Progress. P. Armer. February 1966.
Reprinted from the report of the National Commission on Technology, Automation, and Economic Progress. A self-styled technological radical and economic conservative summarizes progress and trends in computer technology and applications to banking, government, health, engineering, and other fields. The amount of raw computing power in the U.S. has been doubling yearly; the author believes that this trend will continue and that computing power will become available like electricity or telephone service. Full employment can be maintained despite the increased productivity, but ways must be found to minimize the hardships of the displaced. Education must be a continuing process throughout life and society must provide financial support. With centralized information in computer files, privacy becomes a major issue. 28 pp.

P-3484 Current Trends in Aerospace Computation and Some Implications. B. Boehm. November 1966.
A discussion of current trends in aerospace computation. Total U.S. computing power is expected to increase by a factor of 1000 in the next ten years. While computers are becoming faster and more efficient, computer software remains a handicraft industry, custom-made and too frequently idiosyncratic. Programs often subtly distort the projects they are intended to assist. Conversion from one machine to another is time-consuming. Programmers should strive for interchangeability, using machine-independent programming languages and modular units. Continuous reexamination of goals is necessary. (Presented at the SSD/Aerospace Workshop on Spaceborne Computer Software at Aerospace Corporation, El Segundo.) 16 pp. Refs.

P-3486 JOSS: Introduction to the System Implementation. G. F. Bryan. November 1966.
A description of the concept, capabilities, hardware, software, language, and usage of JOSS, an on-line time-shared interactive plug-in computing system. JOSS was designed for casual use by problem-solvers rather than for system programmers. The interactive method of thinking at the console is estimated as being ten times faster than the usual problem-inception-to-problem-solution approach to a computer. Every 24 hours, about 3 million JOSS statements are now processed in an average 5.5 milliseconds. Average computation per session is 20,000 statements, leaving enough unused capacity to accommodate 100 consoles or more. Complete hardware description, flow charts, and sample programs are given. (Presented at the Fall Symposium of the Digital Equipment Computer Users Society, November 1966.) 19 pp.

P-3501 Computers and Our Future. M. E. Maron. December 1966.
A statement of information needed for a realistic attack upon the questions of predicting the future impact of computers on society, the social and moral implications, and the actions that might be taken to alter some of the possible consequences. Among the topics are the implications for invasion of privacy, improper manipulation and control; the influence of information feedback and overload; the problem of obtaining individual treatment in a computer-based selection system. What values do we wish to foster? And how fast can corrective action become effective? 10 pp.

P-3504 System Implications of Information Privacy. H. E. Petersen, R. Turn. April 1967.
A detailed account of ways to protect computer systems, especially remotely accessible on-line time-sharing systems, from invasions of privacy. Communication links cannot be physically secured (see RM-3765); the only broadly effective countermeasure against wiretapping methods is privacy transformations (secret codes), which may require additional hardware. Other countermeasures include once-only passwords; electromagnetic shielding to prevent radiation pickup; systematic verification of the integrity of hardware, software, and personnel; checking up on accidental interference and overlong computer session. Hardware breakdowns and the shielding of processors to prevent "tuning in" present unsolved problems. It appears possible to engineer information systems so that the cost of privacy protection is proportional to the amount desired. (Prepared for presentation at the Spring Joint Computer Conference, Atlantic City, April 1967.) 44 pp. Ref.

P-3522 Some Aspects of Man-Computer Communication in Active Monitoring of Automated Checkout. L. Chesler, R. Turn. March 1967.
Wherever hazards exist, tight schedules must be met, and costs of failure are high, human judgment is needed to detect and react to malfunctions in automatic checkout equipment, incorrect program design or execution, and unexpected events. The human monitor must know exactly what the programs should be doing and what they are doing at each instant; the monitor should be able to look ahead, review the past, specify the level of detail of information, and control the rate of checkout. The moving network display with on-line graphical techniques (RM-5183) is outlined as an example of effective information display. Need for such a system increases as existing factory checkout systems approach the limit of their ability to handle equipment complexity and as manual systems are automated. (Prepared for the Fourth Space Congress, Cocoa Beach, Florida, April 1967.) 34 pp. Ref.

P-3523 Remarks on the Question of Privacy Raised by the Automation of Mental Health Records. P. Baran. April 1967.
It is necessary to face issues of the individual's right-to-privacy raised by the future automation of information systems. Systems will be interconnected for both economy and performance, but time-shared computer file systems will not at first have adequate safeguards commensurate with the sensitivity of the information they contain. The problem is thus how to obtain the greatest benefits from such systems with the least danger to privacy. (Presented to the American Orthopsychiatric Association Workshop, Washington, D.C., March 21-23, 1967.)

P-3527 The Professor and the Computer: 1985. B. W. Boehm. February 1967.
A short scenario of a 1985 conversation between a professor and a computer, which reflects the author's belief that extrapolations into the future should point out not only the prospect but also the prob-

lems of implementing future technology. 5 pp.

P-3533 Keeping the Upper Hand in the Man-Computer Partnership. B. W. Boehm. April 1967.
A discussion of the future capabilities of the computer and its role in augmenting human creativity. Rapid increases in hardware performance (e.g., the large-scale integrated circuit) and new organization methods (e.g., the multi-processing concept) have permitted the design and implementation of more flexible systems, with no loss of computational efficiency. The on-line interactive computing system promises to achieve a significant man-computer partnership. The increased productivity of the computer, however, should not be considered an end in itself. Systems analysis will provide a continual reexamination of the relevance of the user's efforts to his goals, and thus ensure that the computer is used to stimulate creativity, not to perpetuate mediocrity. 29 pp. Ref.

P-3544 Security and Privacy in Computer Systems. W. H. Ware. April 1967.
Outlines the configuration of a typical remote-access, multi-user resource-sharing computer system and identifies some of its vulnerabilities to unauthorized divulgence of information. In military terms, this is the computer security problem; in civilian terms, the computer privacy problem. The latter is less clearly structured from both legal and practical viewpoints. There are vulnerabilities of personnel, hardware, software, and especially communications. Eavesdropping, wiretapping, copying, or outright theft of files are possible. Could reasons of national interest lead the professional intelligence effort of a foreign government to focus on a computer network? This paper presents terminology, outlines the problem, and suggests design considerations; detailed technological countermeasures are given in P-3504, "System Implications of Information Privacy." (Presented at the Spring Joint Computer Conference, Atlantic City, April 17-19, 1967.) 32 pp.

P-3560 JOSS: Rubrics. C. L. Baker. March 1967.
A collection of principles to be kept in mind when designing a JOSS-like system, contemplating additions to the JOSS language, or comparing JOSS with other interactive on-line, time-shared remote computing systems. 5 pp.

P-3562 Urban Node in the Information Network. P. Baran, M. Greenberger. April 1967.
A discussion of the technologies of computers and communications in terms of the major contemporary problems of cities. Since the communication of information may well be the most central and most vital function of an urban complex, the information-based technologies could be the next major force in the evolution of the city. Computer-communication technology could foster a widening, sparser distribution of people around the world, with urban pockets of active personal interaction among intellectual, commercial, industrial, and political leaders. Such urban centers would be sources of ideas and top-level decisions and would serve as input nodes in national and transnational information networks. 25 pp. Bibliog.

P-3568 On-Line Computer Classification of Handprinted Chinese Characters as a Translation Aid. G. F. Groner, J. F. Heafner, T. W. Robinson. April 1967.
A method for using sequential positional information to recognize handprinted Chinese characters, and a computer program that uses this method to provide a translation aid. The desired character is drawn on the RAND graphical input tablet and is reproduced on the CRT display page, which includes the asked-for character together with its pronunciation and its identification number in the standard Chinese-English dictionary. The program can be used for any forms that are drawn in a particular sequence of strokes. Both recognition routines (Chinese and Roman characters) analyze the point-by-point locations as each stroke is being drawn, and identify it within milliseconds after completion. The program could be used in preparing a hardcopy dictionary index or teaching aids by use of a graphical output printer. (Prepared for publication in IEEE Transactions on Electronic Computers.) 21 pp. Ref. (See also RM-5016.)

P-3581 An Approach to Software Evaluation. J. D. Tupac. April 1967.
Software evaluation is discussed within the context of RAND's experience in evaluating its computer system. Software has become more significant because of increased dependence on it for system operation and performance. At the same time,

it has become more difficult to evaluate because of increased complexity, greater flexibility and functional capability, and sheer size. Any organization, undertaking an evaluation of its system, must consider two major areas: functional capabilities and performance based on the organization's requirements and goals. At RAND, workload and capacity requirements, desired throughput and accessibility, and cost constraints were used to determine an acceptable cost/performance range. Estimating software performance is the weakest link in an evaluation. If an organization's output is largely dependent on accurate performance prediction, it must select only from systems with working software. 12 pp.

P-3599 Computer Simulation Programming Languages: Perspective and Prognosis. P. J. Kiviat. September 1967.

An overview of the languages devised especially for programming computer simulations developed since 1959. Some are based on transaction flows (GPSS), others on cause-and-effect relationships expressed in events (SIMSCRIPT), activities (CSL), or processes (SIMULA). Other principal differences are static or dynamic storage allocation, levels of indirect referencing, and ability to form complex data structures. Languages may be executed interpretively by a control program (GPSS), may be direct extensions of general-purpose compilers (SIMULA of ALGOL), source languages to compilers (early SIMSCRIPT and CSL, GASP, and FORSIM IV to FORTRAN) or compile directly into assembly code (SIMSCRIPT 1.5, Extended CSL, CSL-2). The trend is away from terseness toward readability and descriptive power. 22 pp. Ref.

P-3600/1 Soviet Cybernetics: Recent News Items, No. 1. Edited by W. B. Holland. February 1967.

The first issue of a periodical review prepared by the staff of the Cybernetics Data Research Project in the Computer Sciences Department of RAND, to appear approximately monthly. Excerpts from the Soviet press on computers, automatic control, and related material are translated or summarized. The feature article is a compilation of data on the newest, fastest, and most highly publicized Soviet computer, the BESM-6. Includes a bibliography of relevant articles and one of photographs in *Pravda* and the weekly *Economics Gazette* for December and January, and in *Izvestiya* for January only. A bibliography of CDRP publications, with abstracts, is appended. 74 pp.

P-3600/2 Soviet Cybernetics: Recent News Items, No. 2. Edited by W. B. Holland. March 1967.

The second issue of a periodical review prepared by the staff of the Cybernetics Data Research Project in the Computer Sciences Department, to appear approximately monthly. Excerpts from the Soviet press on computers, automatic control, and related material are translated or summarized. The March issue features eighteen pages of computer photographs from the book *Mathematical Control Machines*, the table of contents from the collection *Magnetic Elements in Computer Engineering*, an article advocating a return to three-address machines with microprogramming, seven other articles, and short news items. Relevant articles and photography published during February in *Pravda*, *Izvestiya*, the weekly *Economics Gazette*, and the English-language weekly *Moscow News* are listed. 65 pp.

P-3600/3 Soviet Cybernetics: Recent News Items, No. 3. Edited by W. B. Holland. April 1967.

The April 1967 issue features a survey of research on automatic character recognition and text reading. A translated article on heuristic programming claims that Soviet mathematicians are appreciably ahead of their U.S. colleagues in machine pattern recognition and medical diagnostics, probably in chess playing, but behind in breadth of work and in equipping the projects with the best computer hardware. Other items report technical data, research budgets, new construction, a tabular comparison of U.S. and USSR computers, and a symposium on the use of redundancy in information and control systems. Relevant articles and photographs published during March in *Pravda*, *Izvestiya*, the weekly *Economics Gazette*, and the weekly English-language *Moscow News* are listed. 86 pp.

P-3600/4 Soviet Cybernetics: Recent News Items, No. 4. Edited by W. B. Holland. May 1967.

This issue includes a special report on the BESM and M-20 series of computers developed in the Soviet Union. Items translated from the Russian include reports on electronics in the administration of the national economy and on the characteristics and costs of several computers. Relevant articles and photographs published during April in *Pravda*, *Izvestiya*, *Economics Gazette*, *Moscow News*, and Rand publications on Soviet cybernetics and computer technology are listed. 68 pp.

P-3600/5 Soviet Cybernetics: Recent News Items, No. 5. Edited by W. B. Holland. June 1967.
The fifth issue of a periodical review prepared by the staff of the Cybernetics Data Research Project in the Computer Sciences Department. The June issue features articles on management science and systems analysis in the Soviet Union, development of high-productivity computer systems, and a first description and photograph of the M-220 computer. 101 pp.

P-3600/6 Soviet Cybernetics: Recent News Items, No. 6. Edited by W. B. Holland. July 1967.
The July issue features three articles on problems in the Soviet computer industry. The Ministry of the Radio Industry, which manufactures computers, does not equip them with input-output devices, with standard programs, algorithms, or compilers for algorithmic languages. Users must create their own. The best models operate reliably for several hundred hours, but input-output devices break down nearly every day. Magnetic tapes are noninterchangeable, and information can be stored on tape for no longer than a month. Other articles describe the RITM and BESM-3M computers, computer work in Armenia and Novosibirsk, and the new Kiev Management Information System. Also included are annotated listings of relevant articles appearing in the Soviet Press in June 1967, and some photographs. 94 pp.

P-3600/7 Soviet Cybernetics: Recent News Items, No. 7. Edited by W. B. Holland. August 1967.
This issue includes a translation of an anticybernetics polemic, "Whom Does Cybernetics Serve?" published in the Soviet Union in 1953, a report on Soviet Cybernetics highlights for 1966, and articles on problems of dialectics and logic in the development of an understanding of modern natural science and on cybernetics machines of the future. Articles and photographs published in the Soviet press during July are listed. 72 pp.

P-3600/8 Soviet Cybernetics: Recent News Items, No. 8. Edited by W. B. Holland. September 1967.
This issue features a series of articles on problems confronting the computer industry in the Soviet Union. One of the major controversies is that between large, self-supporting, multiple-user computer centers and smaller, self-contained centers attached to individual plants and enterprises. Another is that of large machines versus small machines. The issue also includes a report on an information retrieval conference and an article on the technical specifications of the M-20, BESM-3M, BESM-4, and M-220. 120 pp.

P-3600/9 Soviet Cybernetics: Recent News Items, No. 9. Edited by W. B. Holland. October 1967.
The October issue features a 30-page article by one of the world's leading cyberneticists, Academician V. M. Glushkov, on prospects for automating computer design. Other articles and excerpts deal with Ukrainian computer usage, automation levels and goals, and production history; heuristics as a science; research personnel statistics, USSR and Latvia; announcement of the Nairi-2 computer; design of the Avrora computer by the M-20; an advertisement for the Polish ODRA-1013; and an annotated listing of relevant items in the Soviet press during September 1967. 96 pp.

P-3600/10 Soviet Cybernetics: Recent News Items, No. 10. Edited by W. B. Holland. November 1967.
The November 1967 issue features a 25-page article on the logical organization of the VNIIEM-3 control computer. The issue also includes articles on heuristic programming; the Pattern Recognition Laboratory at Novosibirsk; the Glushkov survey of management systems; the management system at the Barnaul Radio Plant; and on the automation of national planning calculations at the Ukraine GOSPLAN. This latter article mentions problems caused by hardware shortcomings, unreliable tapes, slow input/output, lack of organized program exchange, and shortages of programmers and mathematical economists. The monthly summary of relevant press items reports that Moscow traffic is to be unjammed by sensor- and TV-controlled signals. The present five-year plan calls for over 600 new automated management control systems and 230 computer centers. 81 pp.

P-3600/11 Soviet Cybernetics: Recent News Items, No. 11. Edited by W. B. Holland. December 1967.
The December issue features 50 pages on the most important achievements in cybernetics, computer technology, power engineering, bioengineering, and mathematics during 1966. Progress in computer medical diagnosis for gastric disease, heart disease, and cancer is reported. Other articles list the characteristics of Soviet

computers, development of a nationwide production coding method, and new graphical data-handling devices. The Kiev Engineering-Construction Institute is coordinating a new annual collection of articles on programmed instruction. The Ministry of Defense daily newspaper, Red Star, has been added to the Press Review section. 103 pp.

P-3600/12 Soviet Cybernetics: Recent News Items, No. 12, Index to Issues 1-11. Edited by W. B. Holland; compiled by J. J. Schneider, W. B. Holland. 31 December 1967.

An index of subjects, personalities, organizations, and hardware/software of the 1967 issues of SC:RNI. A special index is included of material on the problems and shortcomings in Soviet computing and related fields. An annotated bibliography of Rand publications on Soviet cybernetics and computer technology (16 items) is appended. 60 pp.

P-3600/13 Soviet Cybernetics: Recent News Items, No. 13. Edited by W. B. Holland. January 1968.

This issue features an article from Pravda: "Cybernetics, XXI Century" by V. M. Glushkov. An article by K. Rudnev, Minister of Instrument Construction, Means of Automation, and Control Systems, discusses the new system of planning and economic stimulation employing computer techniques for the compilation of optimal production plans. A 13-page article on programmed instruction, translated from the Ukrainian, calls for application of PERT methods and for a Marxist-Leninist theory. The secretary of the Scientific-Research Institute of Planning and Norms, A. Petrov, in an article on the needs and difficulties of science management, urges that the Institute coordinate all production management research (contradictory advice now comes to managers from half a dozen institutes). The Izvestiya Sunday Supplement, Nedelya, has been added to the Press Review section. 72 pp.

P-3600/14 Soviet Cybernetics: Recent News Items, No. 14. Edited by W. B. Holland. February 1968.

A 32-page article, translated from the Ukrainian, covers the content, teaching and programming methods, and hardware of programmed instruction. The process is modeled as a complex nonhomogeneous discrete Markov chain. Adaptive teaching machines that respond to the student's entire instructional history--not just the latest answer--individualize instruction and save much time. The best way to cut costs is to transfer to the student such functions as checking answers and searching for the next branch of a program. Other articles give statistics on Russian scientific and technical organizations; describe the Okean hydrographic computer and a very small ferrite diode control computer for tracking systems; comment on a lag in the application of optimal industrial plans; describe the Latvia University Computer Center; predict the future of cybernetics; and discuss cybernetics and troop-control theory. 95 pp.

P-3600/15 Soviet Cybernetics: Recent News Items, No. 15. Edited by W. B. Holland. March 1968.

This issue features a long article on the ATSEMS-1 hybrid analog-digital computing system; research at the Belorussian Engineering Cybernetics Institute; programming automation and new computer languages in Estonia; computerized retrieval Estonia; computerized retrieval for legal information; automation of microcircuit production, using the Kiev-67 unit. Briefly described are the Syntax-1 electronic machine that checks computer programs for errors, the M-3M computer, the new science of documentation, and what appears to be the first Soviet use of the light pen (for processing amplitude radiation spectra). 72 pp.

P-3600/16 Soviet Cybernetics: Recent News Items, No. 16. Edited by P. L. Stephan. April 1968.

The April issue features (1) a detailed description of the Minsk-23 computer; (2) a critique of computer usage in 70 higher educational institutions; (3) cost factors for the VNIIEM-3 production control system, which runs to 662,000 rubles overall; and (4) computer assistance to researchers. Shorter articles describe remote diagnosis of electrocardiograms transmitted by telephone, with 95 percent accuracy in myocardial infarction cases; the first automated system for producing TV sets; feedback instruments for training athletes; the ATsS production control and management system; publishing activities of the USSR Academy of Sciences; and a new method for automatic modeling which uses a multichannel self-teaching optimizer developed at a Latvian institute. 78 pp.

P-3600/17 Soviet Cybernetics: Recent News Items, No. 17. Edited by D. McDonald. May 1968.

Several articles in this issue discuss how economic planning is hampered by shortages of computers, desk calculators and abacuses, repairmen, and mathematical economists, by lack of coordination, and by the data problem. Economists and mathematicians spend too much time collecting raw data. The Institute of Automation and Remote Control found that 90 percent of data from the petroleum administrations was never used. An 11-page article describes the Ukrainian achievements in the algorithmization of complex production processes. Other articles discuss magnetic elements in computer engineering, cybernetics in agriculture, the ninth pneumohydroautomation conference, and the institute for designing research facilities. Yuri Gagarin's forthcoming *Psychology and Space* is excerpted. 55 pp.

P-3600/18 Soviet Cybernetics: Recent News Items, No. 18. Edited by D. McDonald. June 1968.

The feature article in this issue is a 19-page summary of the official guidelines for designing intermittent-process control systems. Also included is a translation of the illustrated brochure for the Minsk-22 computer system, which has multiprogramming facility. Other articles report on Hungarian work on automation; space tracking; a symposium on reliability of complex man-machine systems; elections to the Ukrainian Academy of Sciences; and the USSR's first industrial character-reading device, which inputs 150 characters per second with 1 error in 250,000 typed characters. A reprint of a newspaper article discusses music composed by the "Ural-2" from programs compiled by Soviet mathematician Rudolph Zaripov. News excerpts include reports on the first automated coal extraction unit and on plans for a single, nationwide weather forecasting service. 92 pp.

P-3600/19 Soviet Cybernetics: Recent News Items, No. 19. Edited by D. McDonald. July 1968.

This issue features a 10-page technical article describing the automatic programming of hybrid computers via the analog unit, with a process control computer as its partner. It also includes an interview with Academician Engineer-Admiral A. I. Berg, president of the Academy cybernetics council, who states that defectless production is under way in over 5000 enterprises with over 5 million workers, yet pedagogy is so defective that 2 million out of 75 million students are left behind each year. Most pedagogical operations can be done by simple, inexpensive devices made of substandard radio parts. Other articles provide information on (1) specifications of 15 digital computers; (2) an appeal from Poland's deputy chairman for socialist country cooperation in computer production and programming; (3) 5 new computer centers and automated factories; (4) achievements of the Armenian Power Engineering Institute; (5) work of 5 Baltic cybernetics institutes; (6) research plans of the Ukrainian Academy of Sciences; (7) use of computers in prospecting for gold; (8) a computer taught to recognize 50 spoken words. 72 pp.

P-3600/20 Soviet Cybernetics: Recent News Items, No. 20. Edited by D. McDonald. August 1968.

This issue features a 16-page survey of Soviet computer technology, as well as a number of other informative articles: A computerized linguistic information system is being developed at the new structural typology and linguistical statistics laboratory of Moscow University. Ever-increasing production of calculating equipment still lags far behind demand, and existing computers are often inefficiently used, due partly to lack of trained personnel. A number of economic institutes do not even have punchcard equipment, and it may be necessary for them to buy equipment abroad. Each ruble invested in R&D adds 1.45 rubles to the national income, compared with only 39 kopeks gain from ordinary capital investment. Several brief reports are included on (1) conferences on automata theory, on control systems, on optimizing production and distribution, and on the mathematization of knowledge; (2) the contributions of Ukrainian economists; (3) the possibility of a time-sharing computer system; (4) designing water supply networks on the MAVR analog computer; (5) the use of computers in education and statistical linguistics; (6) automated control systems, particularly in electrical power, chemistry, and metallurgy; (7) chess and heuristic programming. 88 pp.

P-3600/21 Soviet Cybernetics: Recent News Items, No. 21. Edited by D. McDonald. September 1968.

Three major articles are featured in this issue: (1) A 14-page survey of data storage devices discusses the field's history, current trends, and future prospects. (2) A 13-page article outlines resolutions adopted toward the development and introduction of computer technology in areas of production, planning, accounting, and management by the Central Committee of the Ukrainian SSR. (3) A 17-page translation of excerpts from a book on the organization and techniques of scientific research deals with dissertations. Other brief articles provide information on computers designed by computers; use of cybernetic methods in military affairs; optimization in space flights and game theory; measuring information systems and biological analysors; high-speed computers in physics research; large computer systems; information processing at Moscow's "frezer" plan (manufacturer of cutting instruments); the "Ritm" system for accounting and control; computers in military construction and building materials industry; and reports from conferences on biological-psychological problems and on problems of the scientific control of industry. 120 pp. (CC)

P-3600/22 Soviet Cybernetics: Recent News Items, No. 22. Edited by D. McDonald. October 1968.
Beginning this issue, comments are provided on the context and significance of articles. October analyses highlight the continuing power struggle between central planners and the ministries of particular industries. That the balance is tipping toward ministerial control is indicated by an article on automated control of machine-building and two articles describing the plans of the Ministry of Higher and Secondary Specialized Education for its own nationwide network of computerized information centers. Continued emphasis on PERT and CPM methods is reflected in an article urging a network planning and control service in each scientific organization, and another from Red Star advocating mathematical methods for commanders down to the company and battalion levels, with examples. General opinion seems to be that OR is useful only at higher levels. An unusual article states that although mathematical methods cannot express complex biological processes, it will soon be possible to express the human psyche in equations. Hardware information includes the fact that Poland is now the second Communist country producing computers. 84 pp. (MW)

P-3600/23 Soviet Cybernetics: Recent News Items, No. 23. Edited by D. McDonald. November 1968.
This issue features excerpts from two articles. The first discusses the problem of negative social consequences of automation in a socialist economy. Denying that automation is simply an extension of the industrial revolution and that technical progress has only positive social consequences, the author admits a high degree of scientific and technical progress in capitalist countries and introduces the thought that even under socialism, automation has produced negative social aspects. The second article is a report of the general meeting of the USSR Academy of Sciences, which indicates that the country's first time-sharing system is now operating, but that essential research is being neglected because of fragmented responsibility among the more than ten ministries concerned with machine building. Software problems continue as a focus of attention. Research at the Academy Computing Center emphasizes BESM-6 software, which has not been completed; when it is, the main software effort will be devoted to time-sharing. Other articles discuss cybernetics in criminalistics, trends in network planning and control, spacecraft trajectories, increasing computer efficiency, controlling group behavior with drugs, automation of inventory control, two teaching machines, and new techniques in computer design. 124 pp. (MW)

P-3600/24 Soviet Cybernetics: Recent News Items, No. 24. Edited by D. McDonald. December 1968.
This issue features an article on the reorganization of R&D efforts. Henceforth, there must be a rational accounting for the work of research organization, their operations will be subject to sets of regulations, and they will be required to produce on schedule and to stand behind their work; in return, a series of incentives will reward the successful. An article by Academician A. I. Berg, dealing with the information explosion, points out the serious implications of the paper shortage and a lack of foreign language training. Other articles discuss the need for training in experiment planning and for the information-consultation centers, computerized management of trade and commerce utilizing the theory of information measurement, the Annual Meeting of the Estonian Academy of Sciences, a survey of the computer industry in Czechoslovakia, the conversion of scientific journals to abstracting publications, the results of the Kaskad Production Control system experiment, the Arkus Hybrid Computer, the Asor-2 Computer for network planning, and the need for centralized computer for accountants. 102 pp. (MJP)

P-3600/25 Soviet Cybernetics: Recent News Items, No. 25. Edited by D.

McDonald. 31 December 1968.
A seven-page summary of highlights of the year's contents is followed by three detailed indexes, arranged by subject, by personality, and by organization. An annotated bibliography of 18 Rand publications on Soviet cybernetics and computer technology is appended. 92 pp. (MW)

P-3606 Use of Multiple On-Line, Time-Shared Computer Consoles in Simulation and Gaming. G. M. Northrop. June 1967.
A progress report on the interactive use of on-line, time-shared JOSS computer consoles in war gaming at Rand during the six months since publicly accessible files were added to JOSS capabilities. By programming consoles to interrogate certain files periodically, a crude but highly serviceable real-time store-and-forward communication system is created. The simple JOSS programming language is perhaps the most important feature, since it makes it possible for game players to contribute to the improvement of programming. When the automated Tactical Air Control System simulation was exercised by five Army ROTC students, the Litton Digital Message Entry Device (DMED) format proved too rigid to cover all FAC information needed, and that the Fighter Duty Officer needs three CRT displays: for FAC requests, aircraft status, and his own assignments of aircraft to missions. A text-only diplomatic message simulation and a data-only sub-launched missile duel are also included. Teletype consoles (Type 33 and 35) can be used as JOSS consoles, permitting participation, regardless of location, through conventional teletype or dataphone connections. 66 pp. Ref.

P-3608 Statistical Considerations in Computer Simulation Experiments. G. S. Fishman. May 1967.
A tutorial given at a symposium on the interface between computer science and statistics sponsored by UCLA Extension, The American Statistical Association (Southern California Chapter), and the Association for Computing Machinery (Los Angeles Chapter), February 1, 1967. This paper describes some fundamental statistical problems that should be recognized at all stages of a system simulation that is, or contains, a queueing network, such as inventory models and job shop manufacturing facilities. Such a simulation is the generation of stochastic processes by Monte Carlo methods. While simulation languages such as SIMSCRIPT and GPSS have been developed and refined during the past decade, very little work has been done in applying statistical methodology to the analysis of computer simulations. 7 pp. Ref. (See also RM-4880, RM-5288.)

P-3625 Some Implications of Automated Design on the Engineering Process. L. S. Hill. July 1967.
The use of computers in three categories of engineering design operations: drawing, theory, and applications. The use of CRT displays for contemporary projects is probably the most exciting development in design automation. In theoretical design activities, preliminary design engineers may eventually use all aspects of computerized design as adjuncts to their work. At present, parts that can be defined mathematically can be designed by means of the computer. Applied to engineering computations, computers provide a means of refining a design by the constant testing and retesting of certain elements. They decrease the possibility of conceptual errors in design by providing a capability for investigating many alternative courses and the use of simulation models. Technological problems remain, however, and cost advantages are hard to prove because engineering cost records are ill-defined. Competitive pressures will be a paramount force in the increasing automation of engineering. 15 pp. Ref.

P-3626 The Computer in Your Future. W. H. Ware. November 1967.
An expanded and popularized version of P-3279, explaining present computers and computer programming procedure in some detail as a background for prediction of future developments, such as the following: Computing power will be readily available, like telephone service. Computers will be small, powerful, inexpensive, easy to use, and will accept natural language and graphical input. Perhaps a broadband communication cable will carry all the information services into each home and workplace: voice, video, facsimile newspaper, data transmission, computing service. Design prototypes and preliminary models will be replaced by computer simulation studies. The computer will touch man in every part of his life, modify his career, transfer blocks of jobs from one industry to another, and force rapid and frequent change upon him. Retraining and reeducation will be the way of life for everyone except those retiring before 1972. 47 pp.

P-3641 The Systems Gap. P. Armer. August 1967.
This paper was written as a guest editorial for the August 1967 issue of Datamation. It compares recent information with observations made in 1959 while the author was in the Soviet Union as a member of the U.S. Computer Delegation. In spite of the intelligence, vigor, and dedication of Soviet computer specialists, the systems gap between the U.S. and the USSR has not been closed. Lack of a profit motive to provide incentive, as well as alternative courses for creative individuals, and to weed out incompetence is cited as the primary cause of this failure. 8 pp.

P-3642 Social Implications of the Computer Utility. P. Armer. August 1967.
As information, as a commodity, becomes inexpensive, widely marketed, and readily available with increased utility-like distribution of computing power, threats to privacy will arise in both public and private sectors. A system of controls will be needed to strike a balance between the common good and the individual's right to privacy. 16 pp. Ref.

P-3648 Data Automation Development and Systems Implementation--Some Problems and Conclusions. A. E. Wessel. August 1967.
A discussion of the problems involved in building an information processing system helpful in planning and decisionmaking, and an example in the form of a JOSS program for patent searching (retrieval by index terms). Operational requirements are difficult to state and are constantly changing. System developers and computer manufacturers often talk decision theory but build administrative data flow and control systems--not direct man-computer interaction for higher-level activities, such as patent examination. An example of such an interactive system is the Rand-U.S. Patent Office experimental system, which is implemented on JOSS. We are just now inputting real patent numbers and real index terms. The building of subject index term lists is one of the reasons for the experiment. 30 pp.

P-3656 The Computer--Hero or Villain? M. Greenberger. August 1967.
The computer has been praised as a boon to civilization and damned as a despoiler of humanistic values; assessments of its capabilities range from "electronic brain" to "glorified slide rule." Today, reality lies a little left of center. Although the computer does not yet participate directly in the education process, it has the potential to provide a mass of data, such as performance statistics, that if properly interpreted cannot but improve the instructional system. Prolific computers as well as prolific authors have been blamed for the information explosion, an explosion that may soon be settled by a computerized information system. Such a system would be as indispensable to the research worker as the library is today. Whether the computer becomes a hero will be determined by the intelligence man displays in its use. 16 pp. Ref.

P-3660 Graphical Aids to Aerospace Vehicle Mission Analysis. B. W. Boehm, J. E. Rieber. October 1967.
Graphic ROCKET, an interactive computer graphics system for aerospace trajectory analysis, is now being developed. It is an adaptation of RAND's Omnibus Calculator of Kinematics of Earth Trajectories. Graphic ROCKET has fewer branches: An online user can wait to see the results of his first run before specifying variations. By reducing the total number of runs required, interactive operations can provide more efficient machine usage, despite the overhead cost, as well as acceleration of the design process. Even a good batch-mode program needs considerable redesign to reorient it toward interactive processing. Emphasis should be on user language, program efficiency, and ease of extending models and considering alternatives. The system designer should not attempt close optimization, but should build a flexible system. 12 pp. Refs.

P-3661 The Dynamic Characteristics of Computer Programs. G. E. Bryan. August 1967.
A discussion of ways to achieve more efficient use of computing facilities. Statistics gathered on actual program runs at Rand demonstrate that substantial gains are possible through a multiplexed mode of operation. A major gain is the easing of problems of storage allocation and secondary storage utilization. 27 pp.

P-3685 Communication Policy Issues for the Coming Computer Utility. P. Baran. May 1968.
An expanded version of P-3466 (which appeared in the Summer 1967 issue of Public Interest) revised for computer system personnel and users of time-shared com-

puter systems. Remote time-sharing systems are very ill served by telephone systems designed for voice communication. In some computer utilities now under consideration, communications account for more than half of the system cost. Present FCC regulations prevent computer users or owners from banding together on a time-sharing basis to concentrate their highly intermittent traffic. Radio or microwave transmission promises great efficiency in data transmission and very low costs, if newer forms of signal processing such as spread spectrum are allowed and if licensing red tape can be reduced. The very high channel use of a shared data link provides a strong case in the competition for space on the frequency spectrum. Federal licensing of system personnel should be considered, to protect users' privacy. 24 pp.

P-3697 On the Problem of Directness in Computer Graphics. T. O. Ellis, W. L. Sibley. March 1968.
A brief commentary on the Rand interactive man-computer graphical system, designed to supplement the film, The GRAIL Project. The cathode-ray-tube screen is conceived as a common working surface for both man and computer (the man writes or draws onto it by writing or drawing on the associated RAND Tablet surface). The CRT display must be updated every 30 or 40 milliseconds to allow the user to keep his attention fixed effortlessly on the screen while interacting with his problem. The system depends heavily on real-time symbol recognition. Functions can be invoked by pressing "virtual buttons"--that is, by pressing the equivalent spot on the Tablet--and there is one hardware button to return the system to sign-in condition. The bulk of the paper consists of sample CRT display formats. 19 pp. Ref. Bibliog.

P-3722 IGS--The Integrated Graphics System for the S-C 4060. G. D. Brown. November 1967.
A description of the Integrated Graphics System, a machine-independent package of FORTRAN subroutines which may be called from FORTRAN, COBOL, PL/1, or machine language programs to produce graphic output on the S-C 4060. IGS eliminates the usual FORTRAN restriction that prevents programmers from addressing a single character directly. The GRAFPAC mode-set concept was used: subroutines can be modified without changing the program by simply adding a footnote to the coding or specifying an option. IGS accepts user coordinates and translates them internally into machine rasters (unless otherwise specified). Special control characters are provided for specifying typographical characters beyond those on the usual keypunch. Users may also produce their own fonts by specifying the vectors. Grids, linear or nonlinear on either axis, are automatically plotted. One subroutine draws an entire graph with a single call. 14 pp. Ref.

P-3734 Computer Simulation in Urban Research. J. P. Crecine. November 1967.
Restricting the term "computer simulation" to models which are surrogates for real-world urban processes, this paper discusses those developed for use in two major areas of emerging research: (1) urban growth, development, and spatial location; (2) local government decisionmaking. It also considers two hybrid efforts aimed at simulating a synthesis of economic, political, and administrative elements of an urban system. The future in the area of decisionmaking appears bright, since progress is being made in the technology for translating abstract ideas, concepts, and symbols into computer language. In the area of urban research, however, a lack of data is limiting development. 27 pp.

P-3742 Curve Fitting and Editing Via Interactive Graphics. A. S. Priver, B. W. Boehm. December 1967.
A brief description of an interactive computer graphical system that allows the user to enter a curve into an IBM 360/40 computer via a RAND Tablet and to try various ways of fitting, editing and displaying the curve on an IBM 2250 display scope. The aim was to extend the analysis of multivariate functions described in RM-4639 from tabular to polynomial methods. Control is by the Tablet stylus exclusively, using software-sensitized areas for pointing and Groner's character recognition scheme (RM-5016) for alphanumeric inputs. (Presented at the ACM Symposium on Interactive Systems for Experimental Applied Mathematics, Washington, August 1967.) 5 pp. Ref.

P-3766 An Interactive Graphic System for Curve Fitting and Editing. A. S. Priver. September 1969.
Documentation without printout of a set of computer graphic routines that allow a user to enter a curve into an IBM 360/40 by tracing it on the RAND Tablet and interactively to specify various ways of fitting, editing, and displaying the curve on

an IBM 2250 scope, thus visualizing the results of using certain methods in approximation theory. Routines are provided to least-squares smooth the data in various ways and to compare the results with a cubic spline (the smoothest of all twice continuously differentiable functions). The cubic spline curve, the least-squares polynomial curve, and the original hand-drawn data curve may be displayed separately, together, or in pairs, with the system rescaling the axes as needed. (The HIGH SPEED SPLINE FIT mode eliminates rescaling.) Pointing the Tablet stylus at PUNCH DATA outputs a set of cards that will recreate the display at any time. To conserve storage, certain small routines are repeated under different names (e.g., ENDPT and ENDPT2) rather than overlaying them. 89 pp. (HW)

P-3780 On the Future Computer Era: Modification of the American Character and the Role of the Engineer, Or, A Little Caution in the Haste to Number. P. Baran. October 1968.

A warning that unintended but disastrous effects on society have resulted from improved and computerized recordkeeping, owing to (1) the habit of limiting the number of variables considered to those easily quantified, (2) the tendency to use records and scores instead of judgment, and (3) the use of information to maximize private profit without regard to the damage inflicted by everybody doing this at once. Using computers, loan and insurance companies screen out the highest-risk groups. Fire or burglary insurance cannot be obtained in areas where business development is most needed. Many people are rendered uninsurable and/or unemployable on the basis of health, education, or past failures or infractions that former generations would have successfully concealed. What future have the 40 percent of all urban youth (90 percent Negro) who will have some brush with the law, when an arrest record bars them forever? Those who understand technology have an obligation to lift their eyes from minimizing subsystem costs and at least be an early warning system for the rest of society. 14 pp. (HW)

P-3810 Block Programming in O/S-360 Assembly Code. R. M. Balzer. May 1968.

A description of a block-programming facility that Rand has incorporated into the basic IBM-360 software. This new facility alters the form of the machine language enough to change the way programmers conceive of and code problems. By means of a set of macros, users can write a program as a hierarchical set of instruction blocks whose execution is controlled by conditional statements, thus providing, at the assembly code level, the IF-THEN-ELSE facility of ALGOL and PL/I. Other conditional statements can occur within an IF block. A formatting program automatically indents the program listing to reflect its structure and provides headings for the beginning and end of each block, adding greatly to program readability and self-documentation. Lines added by the program are immediately recognizable because the line numbers are suppressed, distinguishing them from lines produced by the O/S assembler. 9 pp.

P-3822 Privacy Aspects of the Cashless and Checkless Society. Testimony Before the Senate Subcommittee on Administrative Practice and Procedure. P. Armer. April 1968.

A discussion of the problem of maintaining privacy in an age of computerized credit transactions, and a proposal that some government agency be charged with the responsibility for protecting citizens' privacy. Cost and convenience will ultimately force us to use some form of interconnected electronic payment and bookkeeping network for most transactions, instead of checks and currency. The danger of personal surveillance--electronic snooping--depends largely on the completeness and centralization of records and the speed of transmission. Airline reservation systems (which can include hotels, car rentals, etc.) are a present example of large amounts of current personal information instantly available. There is little sanctuary for economic privacy in a system where any sizable cash transaction is conspicuous. Access to the files must be limited to a few persons who can be trusted. 19 pp. Ref. (See also RM-5495, P-3642.)

P-3838 GRAIL/GPSS: Graphic On-Line Modeling. J. P. Haverty. June 1968.

A status report on the RAND-developed capability for interactive modeling of dynamic systems using the GPSS flowcharting technique on the GRAIL (Graphical Input Language) facilities. Analysts are dissatisfied with the long lead time required to translate a proposed simulation from a logical flow diagram to a detailed set of computer instructions to be keypunched. These steps can be bypassed by working at a GRAIL console, drawing on the RAND Tablet and having the symbols recognized and displayed by the character recognition program. Using the GRAIL/GPSS system increases the analyst's efficiency tenfold to a hundredfold. GRAIL capabilities not yet incorporated include shrinking, enlarging, and moving geometric figures, and monitoring on-line execution of the flow diagram. (Presented at an IBM Seminar on Operations Research in the Aerospace Industry: Models in Planning and Control, Newport Beach, April 1968.) 14 pp. Refs.

P-3861 Simulation Programming Using SIMSCRIPT II. P. J. Kiviat. September 1968.
Description of a computer simulation of production and sales, designed to illustrate as many as possible of the programming features of SIMSCRIPT II in a natural, problem-oriented setting. The paper describes the system to be modeled; outlines problems the model is designed to study (namely, to determine the number of machines needed to provide adequate customer service); lists the complete SIMSCRIPT simulation program, well annotated; and gives a set of typical data cards. The last section works through the program in some detail, explaining the syntax and semantics of the statements. 22 pp.

P-3892 The 360/65: RAND's Next Computer. G. D. Brown. August 1968.
A description of the IBM 360/65 computer system to be installed at RAND, and a definition of the terms used in third-generation computing. Time is measured in nanoseconds--billionths of a second. The basic storage unit is a byte (8 bits, 1 character). The CPU is 3 times as fast as our old 7044. Twice as much core storage will normally be available to each user, and more commands can be contained in a given amount of core. Most data sets (files) can be permanently mounted on disk packs; disks are random-access, can be read twice as fast as tapes, and avoid rewinding. The change from a 36-bit to a 32-bit word means that single precision decimal arithmetic decreases from 9 to 7.2 significant digits. Languages available include COBOL, SIMSCRIPT 1.5 and II, PL/1, RPG (Report Program Generator), MARK IV for file maintenance, JCL for job control. There are two FORTRAN compilers: a fast one with excellent diagnostics for debugging, and a slow one that produces efficient code. Multi-programming with time-slicing makes even I/O-bound jobs like tape sorting economical. It also supports the new interactive RAND Video Graphics System. 11 pp.

P-3894 Computer Software: The Evolution within the Revolution. G. W. Armerding. July 1968.
As the cost of developing and maintaining computer software approaches (perhaps, exceeds) the cost of hardware, programs are being recognized as salable and patentable items in their own right. The cooperative spirit of the pioneers is giving way to competition. Some management information systems are being sold by software houses in competition with those offered free by computer manufacturers. The trend will continue, and reckless competition is sure to come: every programmer is a potential software entrepreneur. The evolution now taking place among those who write computer programs gives rise to the question of whether or not professional programmers will disappear. People who "call" themselves programmers may begin to diminish, but the total of "real" programmers and others who perform functions that could be categorized as programming will increase. Special-purpose time-sharing systems are evolving into general-purpose ones. Increased performance, at lower cost per answer, more than compensates for the overhead cost of software. However, the design loop between hardware and software is not solidly closed; feedback from programmers is inadequate. 14 pp.

P-3903 Third-Generation Computer Trends. B. W. Boehm. August 1968.
A review of trends in computing. By 1975, due primarily to large-scale integrated circuitry, we may expect computers 200 times faster, 1000 times smaller, and 500 times cheaper. Total U.S. computer power will increase by a factor of 1000. However, the speed-versus-storage and efficiency-versus-versatility tradeoffs will continue. Computer systems are built and used with very little feedback, so that there is very little systematic building upon experience. When a study is made of just how engineers are using computers, results may be unexpected. One company found its engineers using old designs rather than new because programs were available to analyze them. System engineering techniques are seldom applied to the production of computer software. Such an analysis of Rand's Graphic ROCKET development resulted in POGO, a program that cut graphics control page development time from days to hours. To design computer systems properly, it is necessary to learn more about how men perceive, how they think, and how they create. 13 pp. Ref. (Prepared for presentation at the 1968 Joint Engineering Management Conference in Philadelphia.)

P-3940/7 The JOSS Newsletter: November 1967-June 1971. S. Marks. July 1971.
A final compilation of 44 issues of the JOSS Newsletter, which has been issued monthly since November 1967 to users of JOSS, Rand's interactive, time-shared computer system designed for the solution of small numerical problems. Although the Newsletter has been discontinued, the JOSS system will continue to be used until renovation is no longer practical. A final version of the JOSS Program Library Catalog was issued in March 1971. Although no more JOSS programs will be abstracted, the read-only protection of the library files will still be available for JOSS programs offered to other users in Rand documentation or by personal communication. This final edition of the Newsletter replaces previous editions of P-3940. 157 pp. (MW)

P-3977 GAPSS (Graphical Analysis Procedures for System Simulation). T. E. Bell. January 1969.
A discussion of two types of computer graphics displays used to analyze data following simulations done in the GPSS language. The results showed that the hybrid display showing changes over time (and utilizing a Gantt chart) was superior to the display sequentially presenting individual states of a system. Additional general conclusions are that (1) an analyst almost never views simulation data the right way on the first try; (2) computer graphics helps an analyst identify relationships obscured by summary statistics; (3) computer graphics displays should be tested for usefulness by the people for whom they are designed. 13 pp. Ref. (MJP)

P-3998 The Tenth Rand Computing Symposium. Edited by F. J. Gruenberger. December 1968.
An edited and condensed transcript of the Tenth Annual Computer Symposium held at The Rand Corporation, 13 November 1967. Scheduling the symposium one day prior to the Fall Joint Computer Conference allows top men in the information-processing field to contribute their time and talents. This transcript, edited from the original by each of the attendees, reflects serious but unprepared thoughts on the topic, "The Teaching of Computing." The questions discussed included the people to whom computing should be taught; the grade level at which computer education should begin; the training of programmers and of teachers of computing; and the advice that should be given to high schools, junior colleges, and trade schools to help them initiate computer education programs. 114 pp. (MJP)

P-4014 A Graphic Capability for MARK IV. H. Casali, D. Cohen. January 1969.
Prospects of embedding MARK IV in SGS to establish a usable on-line file management system. SGS (Simultaneous Graphics System) is a small time-sharing system that supports six terminals, designed to provide remote access to an IBM 360 computer using IBM 2260 graphic terminals. The user is provided with a full range of text-editing facilities and has the ability to add, delete, or modify data in a file. In many applications, it is desirable to separate data into different files: JCL statements for one, MARK IV requests for another. To test a MARK IV master file of registration cards and three SGS data files, runs were initiated via the 2260 terminal to catalogue the file definitions and prepare a series of reports. Improvements in entering formatted data need to be implemented. Additional storage devices and remote consoles, as well as conversion to a multiprogramming system such as OS/MVT would probably enhance the capabilities of the system. 8 pp. (KB)

P-4019 Computers and the Delivery of Medical Care. E. C. DeLand, W. F. Raub, R. W. Stacy, B. D. Waxman. February 1969.
The Introduction to Computers in Biomedical Research, Vol. III, evaluating accomplishments over a 3-year period and predicting areas for future emphasis. Characteristics distinguishing recent computer systems from those in the past include increased complexity, flexibility, and capacity for improving health-care services. Work is being done to implement present image processing techniques and, in addition, to promote computer-aided instruction in regard to biomedicine. In the future, mathematical models combined with graphic and flexible forms of data presentation could become an integral part of research hospitals, monitored patient wards and clinics, and basic research laboratories. Interactive computer terminals and the attendant central processor software will be useful for hospital communications, for model building and hypothesis testing, for patient autointerview, for perusing files of data and for other tasks requiring the transfer or analysis of data. 20 pp. (KB)

P-4208 On Limits in Computing Power. W. H. Ware. October 1969.

A paper presented at the 1969 Air Force Academy Meteorological Technical Exchange Conference, on the fundamental physical limits to computer speed. Heat dissipation is the most serious apparent constraint. Switching cannot be faster than 10 (exp -11) sec because of cooling, or 10 (exp -15) sec because of indeterminancy. Present production devices switch at about 10 (exp -8) sec, so 100- to 1000-fold improvement seems to be the limit--not enough to handle complex environmental problems. Beyond that we must look to multistream (rather than serial) processing, as planned for Illiac IV. This may offer a 100-fold increase (its builders hope for many hundreds). If problems prove to be more parallel than we think, and if we push technology to its limits, the overall improvement could move toward 100,000-fold. Such a computer would require special funding, though probably less than a large particle accelerator. 8 pp. (MW)

P-4214 Testimony Before the Assembly Statewide Information Policy Committee. W. H. Ware. October 1969.

A statement before a State Assembly committee on the problem of protecting computer information. The main policy issue is that of the invasion of privacy. The computer-based files of information compiled for ease in checking credit do benefit the citizen, but nonetheless threaten him because of the current lack of legal or industry controls on information dissemination. Technically, the problem is one of lagging system-design expertise, which would be alleviated through the stimulation provided by legal constraints. Self-policing among file operators is unlikely, and legal penalties may have to be imposed in the civilian sector similar to those for defense classified systems. The high reliability in protecting computer-based file information in the defense systems is due to a concerted effort to coordinate hardware, software, management, and physical protective schemes. Only this combination could secure computer systems in the civilian sector, as well. 7 pp. (EB)

P-4221 The Parallel, Pipeline, and Conventional Computer. W. R. Graham. October 1969.

Analysis of parallel and pipeline computers, giving two quantitative bases for computer selection and program construction: (1) the single stage and program execution times required by the two types of machines, and (2) the single stage and complete program efficiencies. Comparison shows that in execution time the results are mixed and it is possible for the advantage to shift between the two machines as the number of steps in a stage increases. Program efficiency is expressed as the ratio of the time required to execute a program if the computer is operating at unit efficiency to the actual execution time. Conceptually new, the parallel computer is based on the idea that two conventional machines can work at twice the rate of one. The pipeline processor gains its edge on the conventional machine by starting retrieval of a second operand before the first result has been returned to the memory. 8 pp. (TC)

P-4251 Logical Aspects of Question-Answering by Computer. J. L. Kuhns. December 1969.

The problem of computerized question-answering is considered from the point of view of relational logic. Three aspects of the problem are defined and interrelated--transforming natural-language questions into symbolic questions (retrieval prescriptions), structuring the file, calculating value sets (answering the question). An experimental program for automatically producing symbolic questions is explained. Finally, the problem of calculating value sets is discussed. A key issue here is the identification of questions that are "unreasonable." It is shown that a logical characterization of permissible input queries is possible and that this characterization can be expressed in terms of machine-recognizable sufficient conditions. 32 pp. Ref. (Author)

P-4313 Computer Aided Advanced Design and Performance of Airborne Vehicles. J. R. Gebman. March 1970.

Description of an operations research tool for easily determining the gross design and performance parameters of almost any proposed airborne vehicle: a comprehensive system of computer routines, modularized down to the level of basic analyses of fundamental hardware components, and assembled into logical subsystems that are independent of vehicle configuration. A prototype FORTRAN IV implementation, including over 130 subroutines, 18,000 IBM cards, and 17,000-element data bank, can be used by employing only 10 or 20 cards. It comprises REGSYS, for determining empirical weight-estimating relationships through multiple regression analysis, and AIRSYS, for design and performance analysis. Programming a final version would probably be too burdensome for any one organization, but the overall program is so arranged that separate aerospace research groups could contribute their proved programs to make a tool usable by all. (Intended for the MORS 1970 Symposium, the document consists mainly of briefing charts.) 28 pp. (MW)

P-4329 Computer Data Banks and Security Controls. W. H. Ware. March 1970.
Guidelines for controls that protect privacy of information within the computer and govern its divulgence to authorized users. Five technical safeguards are needed: (1) protection of central and demountable computer storage media; (2) encryption or physical protection of the circuits; (3) computer hardware safeguards of the time-sharing system; (4) software safeguards to monitor user access to files; and (5) administrative and management controls that are security conscious. Government regulation may be required to protect the privacy of personal files, since there is no data bank "industry" or trade organization for self-policing, and since the operator, who is necessarily profit-oriented, may not know nor care to what use his client wants to put the data. Consequently, safeguards should be formulated before data banks proliferate widely and without control. 12 pp. (MT)

P-4401 The Impact of Future Developments in Computer Technology. W. R. Graham. June 1970.
Compares the relative advantages of two new computers, the University of Illinois' parallel-organized ILLIAC IV and the Control Data Corporation's pipeline-organized STAR. Both increase computing speed by their overall organization. The parallel design drives many identical copies of the conventional computer's arithmetic unit with only one control unit, which obtains, decodes, and issues instructions. The pipeline processor starts retrieving a second set of operands, located in memory adjacent to the first, before the first result has been returned to the memory. The STAR and an ILLIAC IV quadrant have comparable speeds for adding, though the ILLIAC forms a few sums more quickly. In multiplication, the ILLIAC is always faster. In division, the STAR is about twice as fast as the ILLIAC in finding a single quotient, but the ILLIAC is about 1.4 times faster in calculating a long sequence of quotients. 15 pp. (LC)

P-4410 Modeling Continuous Systems with BIOMOD--A Preliminary Report. R. Clark, G. F. Groner, R. A. Berman. August 1970.
Models a fluid reservoir system using the current version of BIOMOD, an interactive computer-graphics system for biological modeling. The BIOMOD system features interaction with immediate feedback, hierarchical model structuring, and user-oriented model-definition languages. It operates on an interactive graphics console comprising a CRT screen, a RAND Tablet, and a keyboard. The user may draw block diagrams, handprint or type text, push displayed "buttons" to initiate certain actions, and move labels. He may represent a model by a block diagram, each component of which may be defined by another block diagram. This facilitates devising complex models one portion at a time. When BIOMOD is completed, the user may define model components by chemical equations, differential equations, or data curves, rather than having to translate his model description into a conventional simulation language. During model simulation, the user may display curves for different variables, change scales, or alter simulation parameters. 41 pp. Ref. (LC)

P-4417 Programming--The Quiet Evolution. G. D. Brown. July 1970.
The glamour period of programming is over. Disenchanted by errors in billing and ballot counting, and dissatisfied with the quality of computer output, the public wants reliable products more than new ideas. Reprogramming for third-generation hardware has taught programmers to value compatibility--known in other fields as tradition and consistency. Old programming languages never die; each new one gives programmers more to learn. In the future, programmers will spend less time coding new algorithms and more time maintaining existing programs. Eighty percent of their time and effort will go to the unexciting but necessary tasks of checkout, documentation, and production engineering of programs for usefulness. The gain in quality means a loss in diversity, as picturesque old-timers are replaced by sober computer science graduates more like accountants. No economies of scale are discernible. It remains true that the fewer programmers working on a task, the better its chances for success. 11 pp. (MW)

P-4428 MAX: A FORTRAN Chess Player. J. J. Gillogly. July 1970.
Describes MAX, a chess-playing program written in standard FORTRAN IV that uses a standard alpha-beta lookahead search of selected portions of the move tree. The program has played several complete games and many incomplete ones between frequent periods of major revisions; its quality

of play ranges from poor to fair. 8 pp. Bibliog. (Author)

P-4446 Evaluation and Innovation in Urban Research. G. D. Brewer. August 1970.
Analyzes the methodology of computer simulation in the social sciences and its ability to manage complexly organized systems. The "in principle" arguments advanced in support of the method have been insufficiently tempered by honest appraisal of past "in practice" experiences. A continuation of the existing trends could harm both the method and the processes of problemsolving in a social context. An initial problem is the development of an appraisal function--i.e., a series of questions or criteria against which a computer simulation may be judged. The experiences from 2 empirical contexts are related in efforts to construct a so-called policy-assisting class of simulation models. Deficiencies in the appraisal included the vastly different orientations of participants interviewed, salesmanship, and various technical and theoretical shortcomings. 47 pp. (KB)

P-4448 Comparing Behavior at Various Computer Display Consoles in Time-Shared Legal Information. J. H. Carlisle. September 1970.
An experiment at Yale Law School in searching for legal precedents on the Mead Data Central time-shared information retrieval system. Subjects used either a teletype or the complicated-to-use CCI video console to access the 300,000,000 character Ohio Bar Association data base. The UCLA BIOMED multiple discriminant program was used to analyze the results. Contrary to expectations, subjects spent more time at the video console, despite the longer transmission time of the teletype. More cases were retrieved and browsed at the video console, relevance scores were higher, and subjects were more satisfied. They also made 300 percent more errors. Relevance correlated highly with number of cases retrieved and negatively with time spent searching--contrary to the beliefs of system designers who limit retrieval to save time. Those who retrieved least information took the longest time and achieved the lowest relevance scores. The negative relation between time and relevance is even more marked for the video console users. 46 pp. Ref. (MW)

P-4459-1 How To Store It. B. Fox. March 1971.
Storage layout for branch-and-bound algorithms is discussed. A composite branching rule, alternating between backtracking and branching from the point corresponding to the minimum bound, is recommended as the best compromise between reducing storage and the number of iterations. 8 pp. Ref. (Author)

P-4465 Use of SC4060-Produced Microfilm Output in Pseudocolor Transformations. J. C. Lamar. September 1970.
A pseudocolor transformation is produced when each discrete density level in an original, continuous-tone, black-and-white image is represented as a different spectral hue in the transformation. The SC4060 has been employed to produce microfilm output for use in 2 pseudocolor processes that have been developed at Rand. This paper discusses the computer programs and techniques for producing specific density levels in the film and the pseudocolor processes using the film. 10 pp. Ref. (Author)

P-4486 A Stochastic Network Approach to Test and Checkout. L. J. Watters, M. V. Vasilik. October 1970.
Demonstrates the usefulness of GERT simulation for modeling and evaluating policies and processes in the area of test and checkout (see GERT: Graphical Analysis and Review Technique, RM-4973). Some of the latest developments and extensions to a GERT simulation program are employed to model a test plan development process, a general test and checkout process, and specific cases of the latter. (Presented at the Fourth Conference on Applications of Simulation, sponsored by AIIE, ACM, IEEE, SHARE, SCI, and TIMS, in New York, December 1970.) 31 pp. Ref. (Author)

P-4503 Interactive Simulation of Continuous Systems: Progress and Prospects. G. A. Bekey, E. C. DeLand. January 1971.
The development of a simulation system that would provide both the interactive, user-oriented features of analog computers and the precision, memory, and computing power of the digital computer has been a design objective for many years. This paper reviews the background of present-day continuous systems simulation techniques, with emphasis on interactive, graphic-oriented systems. The state of the art is discussed, particularly as it concerns user convenience, interactive features, the use

of block diagram descriptions, and graphic displays. BIOMOD, a system recently developed for simulation of biological systems, is used as an example. Limitations of present-day systems and prospects for near-future development are discussed. 21 pp. Ref. (Author)

P-4532 Admatch, A Computer Tool for Urban Studies. A. H. Rosenthal. December 1970.
Description of Admatch, a set of computer programs for matching geographic codes from a reference file to local data records that contain house addresses. The geographic codes may include zip codes, census tracts, congressional districts, and marketing areas. Admatch requires two machine-readable files: a local data file and a reference file. The preprocessing program uses expandable tables that allow variations in street name configurations or alternative spellings of street or street type. The matcher program specifies the level of discrepancy that can exist between the reference file and the data file and still permit the record for the data file to be matched. The postprocessor program combines rejects from the preprocessing step with the accepted records from the matching step. Discussion covers the role that Rand has played in testing and developing the Admatch programs, defines the equipment, and forecasts applications to urban studies. 13 pp. (KB)

P-4536-1 The Use of Computer System Accounting Data To Measure the Effect of a System Modification. R. A. Watson. March 1971.
Nearly all computer systems in operation are equipped with an accounting system that records the computer resources used by each job processed. These data, although having a great potential for use in the measurement and evaluation of computer system performance, are seldom used for anything other than charging for computer services used. This paper discusses techniques for reducing and analyzing accounting data to use in measuring the effect of a system modification. Two different methods are used in analyzing the data, both involving the use of statistical analysis. One method uses regression analysis while the other method uses cluster analysis. 15 pp. (Author)

P-4581 Potential Uses of the Computer in Criminal Courts. P. W. Greenwood. February 1971.
The computer is often touted as the potential savior of organizations finding themselves inundated by paperwork--a position in which the courts find themselves today. Some examples of information systems for court use are presented that illustrate various levels of man-computer interaction in the decisionmaking process. A proposal for experimenting with videotape and computers to solve many of the problems associated with long trials is also described. Its chief benefits would be a large reduction in time required of jurors for each trial and a tremendous cost saving for retrials. Problems of living with the computer are also discussed, along with advice on how to avoid these problems. (Presented at a Chief Judges and Court Administration Conference sponsored by the National College of State Trial Judges, Williamsburg, Virginia, February 1971.) 11 pp. (Author)

P-4585 Computer Memory Management at Rand. A. C. Shetler, S. Glaseman. May 1971.
Describes and lists some relatively simple modifications to the initiator of Rand's 360/65 computer software that enable the Rand Computation Center to run batch jobs at one high speed while running on-line and remote entry jobs in 2 kinds of low-speed memory. The change became necessary with the addition of the slowest memory, LCS, which requires 8 times as many processor cycles for a given job as core storage. The new fixed initiators, which take less than 100 bytes of nonresident memory, have exceeded expectations in managing 3 access speeds of storage, while guaranteeing on-line access and protecting batch jobs from accidentally executing at low speed. Certain regions of memory too small for user tasks are left unfenced, to provide for operation aids and batch readers and writers. The bulk of the paper lists the modified control sections. 106 pp. (MW)

P-4600 Instructional Uses of the Computer in Higher Education. R. E. Levien. March 1971.
Some conclusions about developments in the computer's capabilities and costs; methods of providing computer service and instructional materials; and effects of higher education. Two major trends hold special promise: the development of large, centralized computing facilities shared by customers; and the creation of inexpensive minicomputers, using an exchangeable medium such as magnetic tape cassettes. These could provide a market for computer-based instructional materials; such a market is critical in achieving the desirable level of computer use in instruc-

tion. National policy should see that access to the computer is possible wherever its use is cost-effective, and that its use is refined and improved to broaden the range of instructional value. The federal government should support (1) R&D on hardware and software, including terminals, minicomputers, and intercomputer communications; (2) development of instructional materials; (3) computer experiments; and (4) consideration of computer requirements in copyright and patent laws and communications industry regulations. 20 pp. (SM)

P-4629 A Selective Bibliography of Computer Graphics. R. H. Anderson. April 1971.
An unannotated listing of recent books, articles, theses, papers, and reports on selected aspects of computer graphics and films illustrating computer gaphics research and applications. Items are listed by first author mentioned, under these headings: (1) general; (2) graphics applications; (3) computer-aided design; (4) animation techniques; (5) computer-generated graphic art; (6) graphics languages and subroutine packages; (7) graphic text manipulation, programming, and debugging; (8) list and ring data structures; (9) data structures for associative access; (10) picture languages and grammars; (11) projections and transformations; (12) hidden line elimination and surface shading; (13) hardware; and (14) films. Not included are image processing and enhancement, or pattern recognition or character recognition by other than linguistic means. 34 pp. (MW)

P-4640 Institutions, Innovation, and Incentives. R. E. Levien. May 1971.
A discussion of the importance of achieving effective innovation in computer-assisted instruction. Meaningful innovation can be accomplished only by changing the system --that is, by changing not only the technology, but also the institutions and persons involved. The author presents 2 case histories: design of the proposed National Institute of Education, supporting creation of an R&D base for educational innovation; and design of the system of institutions and technology needed to make instructional use of the computer in higher education truly effective. To achieve innovation, one must plan institutions to encourage and facilitate it, paying careful attention to financial incentives. Instructional use of computers today has a cottage-industry character. Two trends may change this situation: commercial timeshared computer service and cheap, standardized mini-computers programmed through an exchangeable medium such as a cassette. Change would require the concerted efforts of higher educational institutions, timesharing industries, publishers, and the government. 15 pp. Ref. (SM)

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Quantity	Publication	AD Number*	Cost**	Total Cost
	P-3476	642 368	1.00	
	P-3478	650 145	2.00	
	P-3484	643 964	1.00	
	P-3486	644 339	1.00	
	P-3501	644 960	.50	
	P-3504	650 847	2.00	
	P-3522	648 553	2.00	
	P-3523	651 417	.50	
	P-3527	646 880	.50	
	P-3533	650 371	2.00	
	P-3544	650 810	2.00	
	P-3560	649 321	.50	
	P-3562	651 109	1.00	
	P-3568	650 500	1.00	
	P-3581	651 812	1.00	
	P-3599	659 358	1.00	
	P-3600/1	648 594	3.00	
	P-3600/2	649 251	3.00	
	P-3600/3	650 944	3.00	
	P-3600/4	651 869	3.00	
	P-3600/5	653 937	4.00	
	P-3600/6	655 761	3.00	
	P-3600/7	657 004	3.00	
	P-3600/8	658 818	4.00	
	P-3600/9	660 834	4.00	
	P-3600/10	662 333	3.00	
	P-3600/11	663 229	4.00	
	P-3600/12	664 041	3.00	
	P-3600/13	665 103	3.00	
	P-3600/14	665 835	3.00	
	P-3600/15	666 654	3.00	
	P-3600/16	669 070	3.00	
	P-3600/17	670 148	3.00	
	P-3600/18	671 109	3.00	

Quantity	Publication	AD Number*	Cost**	Total Cost
	P-3600/19	672 949	3.00	
	P-3600/20	673 833	3.00	
	P-3600/21	675 978	4.00	
	P-3600/22	677 362	3.00	
	P-3600/23	679 014	4.00	
	P-3600/24	680 741	4.00	
	P-3600/25	685 701	3.00	
	P-3606	654 678	3.00	
	P-3608	653 174	.50	
	P-3625	655 065	1.00	
	P-3626	661 551	2.00	
	P-3641	657 329	.50	
	P-3642	658 249	1.00	
	P-3648	657 005	2.00	
	P-3656	657 812	1.00	
	P-3660	659 352	1.00	
	P-3661	658 819	2.00	
	P-3685	670 505	1.00	
	P-3697	672 993	1.00	
	P-3722	662 008	1.00	
	P-3734	662 339	2.00	
	P-3742	663 228	.50	
	P-3766	693 920	3.00	
	P-3780	677 198	1.00	
	P-3810	670 503	.50	
	P-3822	669 071	1.00	
	P-3838	671 917	1.00	
	P-3861	674 772	1.00	
	P-3892	673 827	1.00	
	P-3894	673 333	1.00	
	P-3903	673 830	1.00	
	P-3940/7		4.00	
	P-3977	682 950	1.00	
	P-3998		4.00	

Quantity	Publication	AD Number*	Cost**	Total Cost
	P-4014	681 108	.50	
	P-4019	682 952	1.00	
	P-4208	694 745	.50	
	P-4214	695 759	.50	
	P-4221	696 109	.50	
	P-4251	698 185	2.00	
	P-4313	704 133	2.00	
	P-4329	703 281	1.00	
	P-4401	710 262	1.00	
	P-4410	711 034	2.00	
	P-4417	709 536	1.00	
	P-4428	710 574	.50	
	P-4446	711 734	2.00	
	P-4448	712 695	2.00	
	P-4459-1	713 617	.50	
	P-4465	713 901	.50	
	P-4486		2.00	
	P-4503		1.00	
	P-4532		1.00	
	P-4536-1		1.00	
	P-4581		1.00	
	P-4585		4.00	
	P-4600		1.00	
	P-4629		2.00	
	P-4640		1.00	